
COMMONWEALTH of VIRGINIA

Conservation Planning for Natural Areas of Colonial National Historical Park, Virginia

Prepared for:
United States Department of the Interior
National Park Service

Virginia Department of Conservation and Recreation
Division of Natural Heritage
Natural Heritage Technical Report 98-14
July 1998



Department of Conservation & Recreation

CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

**CONSERVATION PLANNING FOR THE NATURAL AREAS
OF COLONIAL NATIONAL HISTORICAL PARK, VIRGINIA**

by

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prepared for

U.S. Department of the Interior
National Park Service
Colonial National Historical Park
Yorktown, Virginia
contract # 1443PX429093335

This report may be cited as follows:

Clark, K. H., and C. D. Rafkind. 1998. Conservation Planning for the Natural Areas of Colonial National Historical Park, Virginia. Natural Heritage Technical Report 98-14. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. 100 pages plus appendices.

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ACKNOWLEDGMENTS

Funding for this project was provided by the United States Department of the Interior, National Park Service, through contract number 1443PX429093335.

We wish to thank the staff of Colonial National Historical Park for their support of this project and commend them for their commitment to conservation of natural heritage resources. The authors wish to thank Dave Frederick for producing the GIS maps in this report.

The staff of the Virginia Department of Conservation and Recreation's Division of Natural Heritage contributed expertise and assistance to this project. Caren Caljouw, Rick Myers, Larry Smith, Steve Roble, Chris Ludwig, and Tom Rawinski were especially helpful with technical advice. Faye McKinney and Pat Jarrell were essential to the administrative aspects of this project. Several scientific experts outside the Division of Natural Heritage provided vital information to the project: Michael Focazio (U.S. Geologic Survey), Dana Bradshaw (Center for Conservation Biology), Ruth Beck (College of William and Mary), John Holsinger (Old Dominion University), Nancy Ibison (Division of Soil and Water Conservation), and Donna Ware (College of William and Mary). Some of the text in the introductory sections of this report are paraphrased from other natural heritage reports; we thank Christopher Clampitt, Christopher Ludwig, Kurt Buhlman, Christopher Pague, and Melissa Donoff for allowing us to use their work.

The following individuals reviewed one or more drafts of this report which benefitted from their comments: Cynthia Taylor (York County), Gerald Johnson (College of William and Mary), Caren Caljouw, Sandra Erdle, Larry Smith, Rick Myers (DCR, Division of Natural Heritage), Michele Batcheller (National Park Service), Cindy Schulz (U.S. Fish and Wildlife Service), and Rick Berquist (College of William and Mary).

PROJECT CHRONOLOGY

In 1988, a Cooperative Agreement between the Department of Conservation and Recreation, Natural Heritage Program (now the Division of Natural Heritage), and the National Park Service was developed and signed. This agreement permitted Natural Heritage staff to gather data on locations and management needs of rare species and significant natural communities in and near eight Mid-Atlantic Region national parks, including the Colonial National Historical Park. From 1989 to 1991, an inventory of natural heritage resources was conducted and summarized in a final report entitled: *A Natural Heritage Inventory of Mid-Atlantic Region National Parks in Virginia: Colonial National Historical Park*, Natural Heritage Technical Report #93-6, by Ludwig *et al.* 1993. Subsequently, in 1993, the Department of Conservation and Recreation's Division of Natural Heritage was contracted by the Colonial National Historical Park to conduct site conservation planning for natural areas in and adjacent to the park. These natural areas contain natural heritage resources that were initially identified in the 1993 inventory report, and during subsequent monitoring work that formed part of this conservation planning effort.

During the course of the site conservation planning project, and the ultimate completion of the final report, changes occurred in report format, information needed, sites, resources and personnel, plus state and/or federal status and rank changes of several natural heritage resources. Status and rank changes are reflected in tables and text within the body of the report. This final report offers current, viable recommendations for management and protection of the natural heritage resources of Colonial National Historical Park.

SUMMARY

To meet its legal and policy obligations under National Park Service Management Policies and the Federal Endangered Species Act, Colonial National Historical Park contracted the Virginia Department of Conservation and Recreation's Division of Natural Heritage to conduct site conservation planning for six natural areas in and adjacent to the park. The six natural areas contain natural heritage resources and were initially identified in *A Natural Heritage Inventory of Mid-Atlantic Region National Parks in Virginia: Colonial National Historical Park* (Ludwig *et al.* 1993). **Natural heritage resources**¹ are defined as the habitat of rare plant and animal species, rare or exemplary natural communities, state significant geologic sites, and other natural features of similar interest (§10.1-209 *et seq.*, *Code of Virginia*). **Natural areas**² are areas of land or water which are important to the preservation of natural heritage resources (§10.1-209 *et seq.*, *Code of Virginia*).

The goal of the Colonial National Historical Park conservation planning project is to provide more comprehensive and refined information to guide the protection, preservation, enhancement, understanding, and management of natural areas and associated natural heritage resources on or near Colonial National Historical Park. Site conservation plans for each natural area include revised rarity, occurrence, and biodiversity ranks; additional information on the natural areas discovered after publication of the inventory report; detailed descriptions of the natural heritage resources of each site; a threat assessment; conservation zones designed to attenuate identified threats; and expanded recommendations for protection, monitoring, and management of the site.

The following recommendations are made to Colonial National Historical Park:

continue to vigorously pursue protection and appropriate stewardship of these sites in order to preserve the natural heritage resources they contain,

incorporate the specific protection and stewardship recommendations for each site into Colonial National Historical Park's planning documents,

pursue placement of all six sites on the Virginia Registry of Natural Areas, and continue to include the Virginia Department of Conservation and Recreation and other state and federal natural resource agencies in planning and project review activities related to the six natural areas.

1. "Natural heritage resource" as used by the Virginia Department of Conservation and Recreation is similar to the National Park Service term "rare, threatened, and endangered species." Natural heritage resources also include rare and exemplary natural communities.

2. "Natural area" as used by the Virginia Department of Conservation and Recreation is similar to the National Park Service term "natural zone."

INTRODUCTION

Colonial National Historical Park (COLO, Figure 1) contracted the Virginia Department of Conservation and Recreation (DCR) to develop site conservation plans for natural areas identified within and adjacent to the park. Results of the conservation planning project for these natural areas are presented in this report.

Overview of Natural Heritage Methodology

The Virginia Natural Area Preserves Act of 1989 (§10.1-209 *et seq.*, *Code of Virginia*) directs the Virginia Department of Conservation and Recreation to "preserve the natural diversity of biological resources of the Commonwealth." The Act further establishes the Virginia Natural Heritage Program and requires DCR to develop a natural heritage plan, produce an inventory of the Commonwealth's natural heritage resources, maintain a natural heritage data bank of inventory information, and provide for the protection and stewardship of natural areas. DCR's Division of Natural Heritage fulfills this mandate. DCR is the Commonwealth's principal collector and manager of information on natural heritage resources and performs a variety of protection and stewardship tasks on priority natural areas throughout the state. **Natural heritage resources¹** are defined as "**the habitat of rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest**" (§10.1-209, *Code of Virginia*). The Virginia Natural Area Preserves Act defines **natural area²** as "**any area of land, water, or both...which is important in preserving rare or vanishing flora, fauna, native ecological systems, geologic, natural historical, scenic, or similar features...of the Commonwealth**" (§10.1-209, *Code of Virginia*).

Natural heritage resource information is recorded in DCR's Biological Conservation Datasystem (BCD). BCD consists of integrated map, manual, and computerized information management systems which track a wide variety of natural heritage resources and natural areas information. BCD has applications in natural heritage inventory, natural areas protection, natural areas stewardship, conservation planning, and project review. DCR's BCD is a component of an international network of linked BCD centers found in every state and province in the United States and Canada as well as in many South American, Central American, and Caribbean countries. Methodology standards for consistency and quality control are governed for the entire BCD network by The Nature Conservancy and the Association for Biodiversity Information. *Natural Heritage Resources of Virginia: Rare Vascular Plant Species* and *Natural Heritage Resources of Virginia: Rare Animals*, also known as the Rare Plant List and the Rare Animal List, respectively, are generated from information

1. "Natural heritage resource" as used by the Virginia Department of Conservation and Recreation is similar to the National Park Service term "rare, threatened, and endangered species." "Natural heritage resources" also includes rare and exemplary natural communities.

2. "Natural area" as used by the Virginia Department of Conservation and Recreation is similar to the National Park Service terms "natural zone" and "natural sub-zone."

in BCD and published by the Virginia Department of Conservation and Recreation. All known occurrences of taxa on the Rare Plant List and Rare Animal List are monitored in BCD including information about location, condition, habitat, and threats. The Rare Animal List and the Rare Plant List are compiled by natural heritage staff scientists in cooperation with experts from across the state and the nation. The rare species lists are non-regulatory and science-driven; species are added or removed from the lists based on the most recent and best information available. DCR also tracks a number of rare natural community types, but no list of rare natural communities is published. Plant and animal taxa which do not appear to be of high conservation concern at this time, but which are marginally rare or about which more information is needed, are placed on the plant or animal "watchlist." General population trends are monitored for watchlist taxa, but individual occurrences are not tracked through BCD. If a taxon on the plant or animal watchlist is determined to be rare, it is placed on the appropriate rare species list.

Although almost all species protected under state or federal endangered species laws are natural heritage resources, not all natural heritage resources are listed as endangered or threatened. Identification of a species or community as a natural heritage resource is not a legal status designations but a scientific index of biological rarity. In some cases, however, natural heritage resource information is used by regulatory agencies to help decide which species are proposed for listing under state or federal endangered species laws.

Each natural heritage resource is assigned a rank that indicates its relative rarity on a five point scale (1 = extremely rare, 5 = common) or otherwise indicates the status of the resource with letters (e.g., X = apparently extirpated). Table 1 explains the ranking system in detail. Each natural heritage resource receives two rarity ranks. One rank indicates the resource's rarity throughout its entire range (the global or "G" rank) and the other indicates the resource's rarity within Virginia (the state or "S" rank). For example, the fibrous bladderwort (*Utricularia fibrosa*) is ranked G4G5/S1, indicating that the species is common to uncommon throughout its whole range, but extremely rare in Virginia.

The primary criterion for ranking natural heritage resources is the number of occurrences, that is, the number of known distinct locations containing that resource. For species, the number of individuals at each location or, for highly mobile organisms, the total number of individuals is also important in the ranking process. Other considerations include the conditions of the occurrences, the ratio of protected to unprotected occurrences, and threats.

In addition to ranking each natural heritage resource in terms of rarity, DCR scientists also rank each location or occurrence of natural heritage resources in Virginia on a four point scale (A = excellent, D = poor). Table 1 explains the ranking system in detail. An occurrence of a natural heritage resource is ranked according to its quality (size and vigor, *etc.*), condition (naturalness of habitat, *etc.*), viability (the likelihood of long term survival of the occurrence),

Table 1. Natural Heritage Ranking Systems.

Rank	Description
Natural Heritage Resource Ranking	
S1	extremely rare; usually five or fewer occurrences in the state or may be a few remaining individuals; often especially vulnerable to extirpation
S2	very rare; usually between five and twenty occurrences or with many individuals in fewer occurrences; often susceptible to extirpation
S3	rare; usually between twenty and one hundred occurrences; may have fewer occurrences, but with large numbers of individuals in some populations; may be vulnerable to large-scale disturbances
S4	uncommon; usually more than one hundred occurrences, but may be fewer occurrences with a large number of individuals in some populations; may be restricted to only a portion of the state; not usually vulnerable to immediate threats
S5	common; demonstrably secure under present conditions
SA	accidental in the state
SH	historically known from the state, but not verified for an extended period (usually fifteen or more years); expected that it may be re-discovered
S#N	indicates rarity of non-breeding (usually winter) population of a species in the state
S#B	indicates rarity of breeding (usually summer) population of a species in the state
SU	status uncertain; often because of low search effort or cryptic nature of species
SX	apparently extirpated from the state
State and global ranks are denoted, respectively, with "S" and "G" followed by a character. State rarity ranks are defined above; global rarity ranks are similar, but refer to a species' rarity throughout its entire range.	
Natural Heritage Occurrence Ranking	
A	excellent quality, condition, viability, and defensibility
B	quality, condition, viability, and defensibility combined are considered good
C	quality, condition, viability, and defensibility combined are considered fair
D	quality, condition, viability, and defensibility combined are considered poor
U	occurrence rank undetermined
Biodiversity Ranking of Sites	
B1	exceptional significance, such as the only known site for any natural heritage resource or an A ranked occurrence of a G1 natural heritage resource
B2	very high significance, such as a B, C, or D ranked occurrence of a G1 natural heritage resource or and A or B ranked occurrence of a G2 natural heritage resource
B3	high significance, such as B ranked occurrence of a G3 natural heritage resource
B4	moderate significance, such as a C ranked occurrence of a G3 natural heritage resource or an A occurrence of a G5/S1 or G4/S1 natural heritage resource
B5	general significance, such as D ranked occurrence of a G3 natural heritage resource or a B or C ranked occurrence of a G5/S2 or a G4/S2 natural heritage resource

and defensibility (level of difficulty of protecting the resource). Occurrence ranks used in combination with rarity ranks allow protection efforts to be focused not only on the rarest natural heritage resources but also at the best examples of each.

One of the many ways that DCR uses the ranks of natural heritage resources and their occurrences is to assess the overall biological diversity significance of natural areas. The natural areas may include only one natural heritage resource or may harbor many. Based upon the rarity and occurrence ranks, each site is assigned a biodiversity or "B" rank on a five point scale. Table 1 explains the ranking system in detail. Natural areas which harbor several natural heritage resources may have their B rank upgraded to a level higher than that which would be indicated by the presence of any one of the resources alone. For example, a site containing A-ranked occurrences of four different G4/S1 resources may be ranked B3 instead of B4, the rank indicated for a site containing one or two A-ranked occurrences of G4/S1 resources.

Natural Heritage Inventory of COLO

From 1989 to 1991, the Virginia Department of Conservation and Recreation's Division of Natural Heritage conducted an inventory for natural heritage resources in and near eight Mid-Atlantic Region national parks including COLO. *A Natural Heritage Inventory of Mid-Atlantic Region National Parks in Virginia: Colonial National Historical Park* (Ludwig *et al.* 1993) presents the inventory methods, results, and recommendations.

The inventory was conducted in three steps. First, existing information was gathered on the landscape, biota, and natural heritage resources known near or within COLO. Second, field surveys of areas identified as having potential to contain natural heritage resources were conducted to gather data on rare species and significant natural communities. Third, site boundaries and management recommendations were developed to protect natural heritage resources in and near the park.

During the 1989-1991 inventory, twenty-two occurrences of natural heritage resources were documented. These occurrences represented 16 rare species and one rare community type (Table 2). Based on these natural heritage resource occurrences, nine natural areas were identified (Figure 2). Individual site accounts for each natural area were included in Ludwig *et al.* (1993). These site accounts presented a list of natural heritage resources, site descriptions, threats to the natural heritage resources, management recommendations, and protection recommendations. Maps with preliminary conservation planning boundaries and resource locations were included with site accounts. For current natural heritage resource information, see Table 6.

Table 2. Natural Heritage Resources Identified by 1989-1991 Inventory Project (Ludwig *et al.*, 1993).

		Number of Occurrences	
Common Name	Scientific Name	Within Park	Adjacent to Park
Plants			
False Hop Sedge	Carex lupuliformis	0	1
Fibrous Bladderwort	Utricularia fibrosa	1	0
Florida Adder's-Mouth	Malaxis spicata	1	0
Loesel's Twayblade	Liparis loeselii	3	0
Mountain Camellia	Stewartia ovata	1	0
Parker's Pipewort	Eriocaulon parkeri	0	1
Shumard's Oak	Quercus shumardii	0	1
Small Whorled Pogonia	Isotria medeoloides	0	1
Southern Twayblade	Listera australis	1	0
Spanish Moss	Tillandsia usneoides	0	1
Virginia Least Trillium	Trillium virginianum var. virginianum	0	1
Animals			
Bald Eagle	Haliaeetus leucocephalus	2	0
Great Blue Heron	Ardea herodias	2	1
Great Egret	Casmerodius albus	1	0
Least Bittern	Ixobrychus exilis	1	0
Northern Spring Sideswimmer	Gammarus pseudolimnaeus	1	0
Natural Communities			
Tidal Brackish Marsh	mid-height herbaceous estuarine wetland	0	1
TOTAL		14	8

1993-1998 Conservation Planning Project

The goal of this conservation planning project is to provide more comprehensive and refined information to guide the management and protection of natural areas on or near COLO. Conservation planning for natural areas of the park is a logical next step after the natural heritage inventory. Additional data regarding each of the sites' natural heritage resources, their ecological needs, and threats were collected. By combining new facts with existing knowledge from the inventory project, the following information on each site is provided in this document:

- revised rarity, occurrence, and biodiversity ranks based on the latest data and protocols;
- additional information regarding the sites discovered after the publication of the inventory report;
- a threat assessment;
- conservation zones designed to attenuate the threats identified;
- detailed descriptions of each natural heritage resource occurrence; and
- expanded protection, monitoring, and management recommendations.

The purpose of this report is to assist COLO in meeting its responsibilities to preserve, protect, perpetuate, enhance, and manage its natural heritage resources and related rare, threatened, and endangered species. This plan provides the basis for well-informed research, monitoring, planning, education, protection, and general management by the park. This report aids the COLO in efforts to preserve biological diversity.

Information collection, site visits, and development of the conservation plans began in the fall of 1993 and concluded in the summer of 1995. Conservation planning for one natural area identified by the inventory project, Powhatan Creek, can be found in *Conservation Planning for the Natural Areas of the Lower Peninsula of Virginia* (Clark 1993) and is not discussed in this report. Three of the remaining eight natural areas (Cheatham Pond Ravines, Cub Creek, and Jones Millpond) were merged to form a single natural area (Cheatham Ravines) **resulting in a total of six natural areas addressed in this report**. A map of the study area with the relative locations of the six natural areas is presented in Figure 8, and summary information regarding each natural area can be found in Table 5.

Conservation zones and recommendations for protection and management should NOT be interpreted as acquisition boundaries, proclamation boundaries, or regulatory land-use zones. Instead, conservation zones and recommendations should be considered tools to promote an ecosystem approach to wise land use decisions on the complex socio-economic and ecological landscape at all levels of government and in the private sector.

LAWS, REGULATIONS, POLICIES, AND GUIDELINES

Legislative and Planning Issues

The park's *General Management Plan* (NPS 1993A) provides overall management objectives and site specific planning activities for the park. Natural resource related objectives include:

- Protect rare, threatened, and endangered species and their habitats by developing natural sub-zones within historic zones for protection and management of these species and habitats.
- Protect wetlands and floodplains.
- Develop an up-to-date inventory and database of natural resources.
- Develop an active resource monitoring program.
- Cooperate with public agencies and with owners of property that adjoins the park to promote resource preservation and monitoring of land uses that could affect park management.

- Ensure that natural resource management and protection practices in the park are consistent with all applicable laws, policies, executive orders, and other regulations.

The park's *Resource Management Plan* (NPS 1993B) is intended to guide management of cultural and natural resources within the park. One of the items it identifies is specific needs and approaches for research, monitoring, protection, interpretation, and general management of the park's rare, threatened, and endangered species and associated designated critical habitats. This conservation planning project is an action plan of the *Resource Management Plan*. The following specific management objectives were developed to manage the natural resources of the park and to preserve biological diversity and highly significant ecosystem function as part of the park's *Resource Management Plan*:

- Preserve, protect, and interpret ... natural processes/resources in their environment.
- Rare, threatened, or endangered species, as identified through the process established by the Endangered Species Act, will be protected as a part of the naturally evolving ecosystem.
- Restore, protect, and preserve natural watershed(s) conditions and processes and native plant and animal communities that are characteristic of the Coastal Plain.
- Achieve better understanding of ... natural processes through research and monitoring to guide management activities and interpretation including ecologically sound decision-making; gather and evaluate information through research and monitoring in natural science, visitor use, archaeology, history, and land uses to guide decision-making and management actions.
- Provide through interpretation, environmental education, and outreach programs for public understanding, appreciation, involvement, and support.
- Develop and maintain cooperative protection strategies with federal, state, and local government agencies, community groups, corporations, and individuals to protect the integrity of the natural and cultural environments within and surrounding the park.
- Park facilities will be developed, operated, and maintained to avoid adverse impacts to park resources.
- Park operations will be conducted to minimize impacts to natural and cultural resources.

Federal Programs, Laws, and Regulations

A variety of federal, state, and local regulatory programs pertain to the protection and management of natural resources in and adjacent to the park. A summary of these regulatory statutes is provided below.

National Park Service Organic Act (1916)

The Organic Act specifies that the National Park Service (NPS) is responsible for the preservation and conservation of natural resources in all park lands under its jurisdiction. Through this act, Congress established the National Park Service and mandated that it "shall promote and regulate the use of the federal areas known as national parks, monuments, and reservations ... by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

This act was reinforced by Congress in 1970 with legislation stating that all park lands are united by a common preservation purpose, regardless of title or designation. Hence, all water resources in the National Park System are protected equally by Federal Law, and it is the fundamental duty of NPS to protect those resources unless otherwise indicated by Congress.

Redwood National Park Act (1988)

This act amended NPS authorities legislation to direct that within the National Park System, "authorization of activities shall be construed and the protection, management, administration...shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established..." With this additional amendment to NPS law, the NPS is mandated to afford the highest standard of protection and care to park resources; no decision can compromise these resource values, except where specifically authorized by law.

National Environmental Policy Act (1969)

Congress passed the National Environmental Policy Act (NEPA) in 1969. Regulations require the cooperation of federal agencies in the NEPA process. The regulations also encourage the reduction of duplication through cooperation with state and local agencies including early efforts of joint planning, hearings and environmental assessments. The Virginia Department of Environmental Quality coordinates the review of environmental assessments for projects in Virginia.

The natural resource policy direction of NEPA, found in Section 101 of the Act, includes the promotion of "efforts which will prevent or eliminate damage to the environment and to the biosphere" and will "enrich the understanding of ecological systems and ecological resources of the nation." All federal agencies are to use all practicable means to "fulfill the responsibilities of

each generation as trustee of the environment for succeeding generations," and to "maintain, whenever possible, an environment which supports diversity ..."

Endangered Species Act (1966)

The law enacted in 1966 and amended in 1969, 1973, 1978, 1982, and 1988 provides legal protection to species listed under the Act (vertebrates, invertebrates, and plants) and designated critical habitats for those species. It legally defines the terms "threatened," "endangered," and "critical habitats." The Act requires federal agencies to ensure that any action they authorize, fund, or execute is not likely to jeopardize the continued existence of any federally listed threatened or endangered species or result in the destruction of adverse modification of designated critical habitat.

Clean Water Act (1972)

Enacted in 1972 and amended in 1977 and 1987, the Clean Water Act was established to..."restore and maintain the chemical, physical, and biological integrity of the Nation's waters by attaining the goals of providing for the protection of fish, shellfish, wildlife, and recreation..." Section 404 of the Act provides direct wetlands protection by authorizing the U.S. Army Corps of Engineers to prohibit or regulate, through a permit process, discharge of dredged or fill materials into the waters of the United States, including wetlands.

Executive Order for Protection of Wetlands (E.O. 11990)

Executive Order 11990 established a mandate for the NPS and other federal agencies to "...preserve and enhance the natural and beneficial values..." of tidal and non-tidal wetlands and to minimize impacts to them when no practicable alternative to the proposed action exists.

Executive Order for Exotic Organisms (E.O. 11987)

This executive order requires federal agencies to "restrict the introduction of exotic species into the natural ecosystems on lands and waters which they own, lease, or hold for purposes of administration..." and "into any natural ecosystem of the United States," and to "encourage the States, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States" unless the Secretaries of Agriculture or Interior "find that such introduction or exportation will not have an adverse effect on natural ecosystems."

National Park Service Management Policies and Guidelines

The management of the national park system and NPS programs is guided by the Constitution, public laws, proclamations, executive orders, rules and regulations, and directives of the Secretary of the Interior and the Assistant Secretary for Fish and Wildlife and Parks. Service-wide policy is articulated by the Director of the National Park Service, and must be consistent with the above laws, regulations, etc. The *National Park Service Management Policies* (NPS 1988) provide broad policy guidance for planning, land protection, natural and cultural resource management, wilderness preservation and management, interpretation and education, special uses of the parks, park facilities design, and concessions management.

Recommended procedures for implementing service-wide policy are described in the NPS guideline series. The guidelines most directly pertaining to actions affecting this plan include: (1) NPS-2, which provides guidelines for the planning process (NPS 1982A); (2) NPS-12, which addresses compliance with the National Environmental Policy Act including preparation of environmental impact statements, environmental assessments, and categorical exclusions (NPS 1982B); (3) NPS-75, which provides natural resources inventory and monitoring requirements (NPS 1992A); and (4) NPS-77, which guides natural resource management activities (NPS 1992B).

National Park Service Management Policies (NPS 1988) on biological diversity, in part, states:

The National Park Service will strive to protect the full range of genetic types (genotypes) native to plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity. (4:10)

Superintendents will develop agreements with other federal, state, and local agencies, Native American authorities, and private landowners where appropriate to coordinate plant and animal management activities...In addition, superintendents will seek the cooperation of others in minimizing the impacts of outside influences...and other means of preserving and protecting park resources. (4:5)

The *National Park Service Management Policies* (NPS 1988) prescribes management of endangered, threatened, and candidate species in conformance with the Endangered Species Act, recovery plans, and other related documents. *National Park Service Management Policies* (NPS 1988) states:

The National Park Service will identify and promote the conservation of all federally listed threatened, endangered, or candidate species within park boundaries and their critical habitats....The National Park Service also will identify all state and locally listed threatened, endangered, rare, declining, sensitive, or candidate species that are native to and present in the parks, and their critical habitats....All management actions for protection and perpetuation of special status species will be determined through the park's resource management plan. (4:11)

Major program objectives of the management policies include:

- Inventory and monitor sensitive, candidate, and listed species. This includes mapping species' distribution in the park, identifying critical habitats (if any), and determining numbers of individuals, threats to the species, condition, and population trends.

- Manage endangered, threatened, and candidate species, and their critical habitats, in conformance with the Endangered Species Act, recovery plans, and other appurtenant documents.
- Ensure that park operations do not adversely impact endangered, threatened, candidate, or sensitive species or designated critical habitats, within or outside the park.
- To the extent possible, ensure that activities, projects, or programs outside the park do not adversely impact endangered, threatened, candidate, or sensitive species or designated critical habitats within the park.
- Integrate to the fullest extent possible park management actions with other federal, state, and private recovery efforts.
- Ensure appropriate consideration of federal and state listed species and other special status species in all plans and NEPA documents.
- Design and implement research relevant to the preservation of candidate, rare, sensitive, and listed species.

State and Local Programs

Virginia Endangered Species Acts

Virginia has two laws designed to protect endangered species. The Virginia Endangered Species Act (*Virginia Code* §29.1-230 *et seq.*) was passed in 1972 and is administered by the Virginia Department of Game and Inland Fisheries (VDGIF). This legislation prohibits the taking, transportation, sale, *etc.* of endangered and threatened animal species, except by permit.

Virginia's Endangered Plant and Insect Species Act (*Virginia Code* §3.1-1020 *et seq.*) was passed by the General Assembly in 1979 in order to extend protection and management to endangered and threatened species of plants and insects. This act is administered by the Virginia Department of Agriculture and Consumer Services (VDACS) and prohibits the taking or possession of listed species except from a person's own land or by permit.

Virginia Water Quality Standards

The purpose of this statute is to maintain the quality of the waters of the Commonwealth of Virginia "... at such a quality that will protect all existing, beneficial uses attained on or after November 28, 1975 and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them."

In addition to designation of beneficial use and promulgation of appropriate water quality criteria, the U.S. Environmental Protection Agency also requires that all states establish as part of their water quality standards a regulatory doctrine which includes anti-degradation policy for various levels of water quality. In May, 1992 the Virginia Department of Environmental Quality (VDEQ) adopted amendments to the State's water quality standards which allow for the designation of exceptional waters (VR 680-21-01.3.C), defined as those waters which provide exceptional environmental settings, valuable aquatic communities or recreational opportunities. Waterways officially designated as exceptional become protected against further degradation. No new discharge permits will be awarded, and no new point sources or expansion to existing point sources are permitted.

Virginia Wetlands Act

The Commonwealth of Virginia adopted the Virginia Wetlands Act in 1972 (*Virginia Code* §28.2-1300). The Virginia Wetlands Act is confined to a geographic area defined as Tidewater Virginia and applies only to tidal wetlands. The legislation requires a permit for activities in tidal wetlands. Certain activities are specifically excluded from the permit requirement including: noncommercial piers, fences, and catwalks; cultivation of shellfish; agriculture; forestry; normal road maintenance; and outdoor recreation.

The Virginia Marine Resources Commission has oversight at the state level and hears appeals of decisions made at the local level. Originally wetlands were defined under the Virginia Wetlands Act to be those lands contiguous to tidal waters within one and one half times the mean tide range and vegetated with wetlands plants listed in the legislation. However, the vegetation requirement excluded non-vegetated wetland resources, and these wetlands were added by definition in 1982.

Chesapeake Bay Preservation Act

In 1988, Virginia passed the Chesapeake Bay Preservation Act. The act empowered localities to consider water quality issues when making land use decisions. Further, the act required all Tidewater localities to develop and adopt local programs and map sensitive areas. The regulations define Resource Protection Area (RPA) and Resource Management Area (RMA) and provide guidelines on the determination of these areas and the management tools applicable to regulating land use in the RPA's and RMA's (Figure 3).

Resource Protection Areas are those natural areas most sensitive to disturbance; activities in these areas may lead directly to impacts on water quality. The RPA designation includes: tidal wetlands, non-tidal wetlands connected by surface flow and contiguous to tidal wetlands or tributary streams, tidal shores, other lands at local discretion, and buffered areas not less than 100 ft (30 m) in width landward of all other components of RPA's and along both sides of any tributary stream. There is greater latitude given the localities in the designation of RMA's; however, the regulations suggest the consideration of designating the following: non-tidal wetlands (other than those specified as RPA's), floodplains, highly erodible soils, highly permeable soils, and other lands at local discretion.

The regulations promulgated by the Chesapeake Bay Local Assistance Department also include performance criteria for land use and development. The performance criteria address such issues as land clearing, erosion and sediment control, septic systems, storm water management, and best management practices.

NATURAL RESOURCES

Colonial National Historical Park (COLO) is a 9,327 acre (3,775 hectares) unit of the National Park System located within the Coastal Plain of Virginia, on the Lower Peninsula between the York River and the James River (Figure 4). The park, established by Public Law 71-510 in 1930, preserves the historic resources of Jamestown Island, the site of the first permanent English settlement in North America, and the Yorktown Battlefield, scene of the culminating battle of the American Revolution. The Colonial Parkway, a 24 mile (38 km) scenic road, links the Yorktown Battlefield with Jamestown Island. Furthermore, the park has significant natural resources including the second highest number of natural heritage resource occurrences for National Park Service (NPS) areas in Virginia after Shenandoah National Park.

Land Status and Uses

Most of the land of the park is maintained as naturally wooded areas or as open grassed fields. Areas adjacent to the park include extensive land holdings of the U.S. Navy (Naval Weapons Station-Yorktown, Cheatham Annex, Yorktown Fuel Depot), the U.S. Coast Guard (Yorktown Reserve Training Center), the City of Newport News (Newport News Park and Watershed), Colonial Williamsburg, the College of William and Mary, and residential and commercial development around both Yorktown and the Colonial Parkway from Williamsburg to the Jamestown area. With the exception of the U.S. Navy, U.S. Coast Guard, and the City of Newport News holdings, much of the area surrounding COLO is experiencing increasing levels of development. Agriculture and silviculture, while still present in some portions of the park watersheds, are of declining significance. Single family and multi-family residential and commercial development is increasingly prevalent on lands within park watersheds, particularly in the western reaches around Williamsburg. Colonial National Historical Park comprises only a small percentage of the land area within the York River and James River watersheds. (NPS 1994).

Overview of Area Natural Resources

Colonial National Historical Park occupies a corridor 26 miles (42 km) long running across Virginia's Lower Peninsula between the York and James Rivers. The park is located within James City County, York County, and the City of Williamsburg with outlying parcels south of the James River in Surry County, north of the York River in Gloucester County, and at the mouth of the Chesapeake Bay in Virginia Beach.

The Lower Peninsula includes the area in eastern Virginia bounded by the York River to the north, the Chesapeake Bay to the east, and the James River to the south. The following geologic information regarding the Lower Peninsula is adapted from Johnson and Berquist (1989), Johnson (1971), and DMME (1993). The Lower Peninsula lies entirely within the Middle Atlantic Coastal Plain province. The coastal plain exhibits a stair-stepped (terraced)

landscape and is underlain by a thick sequence of over 1,000 ft (300 m) of sediments eroded from the Piedmont and mountains to the west. Terraces decrease in elevation from west to east and toward the major rivers. Terraces are emergent former bay and estuarine bottoms and the scarps, the risers between the terrace treads, are former shorelines. The Surry, Lee Hall, Kingsmill, Suffolk, and Big Bethel scarps cross the natural areas of COLO. Streams have carved steep-sided valleys below the level of the terraces and the Holocene rise of sea level has caused backflooding and filling of the valleys near sea level. Herbaceous emergent wetlands, forested wetlands and low floodplain forests cover the flat-bottomed valleys.

The sequence of sediments below the Lower Peninsula range in age from Cretaceous to Holocene in age, but only deposits of late Miocene to Holocene crop out within the natural areas. The oldest, the marine Eastover Formation, is comprised of a lower sparsely fossiliferous fine sand and an upper very shelly sand. It is late Miocene (8 or 11 million years old) in age. The Yorktown Formation overlies the Eastover and is composed of quartzose to very shelly sand with a diverse shallow marine fossil assemblage. The Yorktown is Pliocene in age (4.2 to 3.4 million years old). Both the Eastover and Yorktown contain aquifers and confining beds and produce alkaline ground water.

The marine formations are capped by fluvial-estuarine and bay deposits of the Bacon's Castle, Windsor, Charles City, Chuckatuck, Shirley, and Tabb formations (Johnson and Berquist 1989). These formations crop out on the coast-wise and riverine terraces. Each formation has a basal gravelly sand and an overlying sand that commonly grades upward into a mud, an admixture of fine sand, silt, and clay. These deposits are considered the Columbia aquifer and generally yield acidic ground water to streams and standing bodies of water. Colluvial deposits are found on nearly all slopes and sinkhole fillings occur sporadically on the Lackey plains and the Grafton and Huntington flats. Geologic mapping efforts in the area are continuing and better information may become available at a later time.

The uplands of the Lower Peninsula are primarily forested or urbanized. Most forests are composed of either hardwoods or mixed pines and hardwoods. Although only a relatively small proportion of the Lower Peninsula is currently in agriculture, most uplands were farmed in the past.

Ravines with steep slopes are common in the Lower Peninsula and most stream channels are narrow, with little development of bottomland forests. Powhatan Swamp is the only extensive forested bottomland on the Lower Peninsula. This area supports a mixture of bald cypress (*Taxodium distichum*), black gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and bottomland oak species (*Quercus* spp.).

Most wetlands in the Lower Peninsula are herbaceous wetlands; the area also includes forested wetlands, vernal pools, and floodplains. Although tides are noticeable along the Chesapeake

Bay's major tributaries over much of the coastal plain, the York and James rivers (and their tributaries) have sufficient flow that they remain fresh for a considerable distance downstream of the Fall Zone. As salinity increases downstream, the diversity of plants and animals in the herbaceous wetlands decreases.

The Lower Peninsula is located between two of Virginia's major metropolitan areas, Richmond to the northwest and Hampton Roads to the southeast. Because of this location, the Lower Peninsula is experiencing high rates of population growth and intense development pressures.

The study area includes hydrologic units of the James River sub-basin from the Fall Zone to Hampton Roads and the York River sub-basin from West Point to the Chesapeake Bay. According to the *Virginia Nonpoint Source Pollution Watershed Assessment Report* (DCR 1993), both of these sub-basins are influenced by some agriculture and forestry related non-point source pollution problems, but urban sources are the most significant contributors to nonpoint source pollution in these sub-basins. Although comprehensive water quality data is not available, elevated bacteria and nutrient levels, shellfish condemnations, and metal contaminations have been documented from parts of these sub-basins (VDEQ 1994). Watersheds in the sub-basins containing the natural areas are listed as medium to high nonpoint source pollution priorities (VDCR 1993).

Overview of Park Natural Resources

Surface Water

More than 32 miles (51 km) of shoreline along the James and York rivers bounds COLO (Figure 5). In addition, approximately 24 miles (38 km) of perennial streams and 31 miles (50 km) of intermittent streams and drainages flow through the park. A drainage divide on the Lower Peninsula marks the point at which water flows either into the York River watershed to the north or James River watershed to the south. This drainage divide line (watershed boundary) roughly corresponds to the path of old U.S. Route 60 (Figure 5).

Numerous freshwater tributaries flow through park lands. As they approach the James and York rivers these tributaries become tidally influenced, estuarine waters. The Colonial Parkway passes among upland and tidal streams, as well as freshwater and brackish ponds. Freshwater springs originate from several points within the park. Numerous ephemeral sinkhole ponds occur on the Yorktown Battlefield and along the Colonial Parkway. The largest known sinkhole on the park is located northeast of the intersection of U.S. 17 and the Colonial Parkway at Yorktown.

Wetlands

Wetlands in the park include forested freshwater communities, herbaceous emergent freshwater communities, and herbaceous emergent tidal communities. The park's GIS inventory indicates that wetlands cover approximately 27% of park lands (Figure 6). Most park wetlands are connected to larger adjacent wetland areas. Most rare, threatened, and endangered species found in the park are associated with one or more of these wetland types. Estuarine emergent, palustrine emergent, and forested wetlands cover almost all of Jamestown Island. Estuarine emergent intertidal wetlands are found along the shorelines of the James and York rivers and adjacent tributary creeks, including Felgate's, Indian Field, Queen, King, Papermill, College, Mill, and Powhatan. Palustrine emergent and forested wetlands are associated with all non-tidal streams in the park, along with certain sites of the parkway in the Williamsburg area, and at the sites of freshwater springs and seeps particularly in the Yorktown area. Jones Mill, Cheatham, Bracken's, and Wormley ponds are also home to palustrine emergent and forested wetlands. Queen Creek is the largest estuarine emergent wetland system in York County, and is partially located inside the Cheatham Annex area of the park. Yorktown Creek and its associated unnamed creek are home to a large estuarine emergent wetland.

Biological Resources

Biological resources of COLO include a wide variety of birds, fish, mammals, aquatic invertebrates, plants, and wetlands typical of the mid-Atlantic Coastal Plain. None of these resources are limited to park lands, but park lands provide important habitat within the larger geographic area.

Flora

National Park Service records report that 593 species of vascular plants from 98 families and 352 genera have been identified within the boundaries of the park (NPS 1986). Predominant vegetation types within the park include approximately 5,540 ac (2,242 ha) of forest (13% of which are forested wetlands), approximately 1,744 ac (706 ha) of tidal and non-tidal emergent (herbaceous) wetlands, and approximately 1,119 acres (453 hectares) of open fields (Figure 7). An important function of the park flora is to screen the park from outside urban intrusions and to enhance its aesthetic environment.

Three types of forests grow on park lands. These include the pine, mixed pine and hardwood, and hardwood forest types. Loblolly pine (*Pinus taeda*) and Virginia pine (*Pinus virginiana*) are the dominant species. A number of hardwood species exist in both the wet and dry areas of the park.

The dry species include tuliptree (*Liquidambar styraciflua*), white oak (*Quercus alba*), willow oak (*Quercus phellos*), black cherry (*Prunus serotina*), red oak (*Quercus rubra*), and mockernut hickory (*Carya alba*). Hardwood species found in the wet or poorly drained soils

include sweet gum (*Liquidambar styraciflua*), white ash (*Fraxinus americana*), red maple (*Acer rubrum*), black walnut (*Juglans nigra*), black gum (*Nyssa sylvatica*), and sycamore (*Platanus occidentalis*).

Each area of the park supports a different type of vegetation. Jamestown Island's pine-oak forests are dominated by loblolly pine. Extensive emergent and forested wetlands are found on the island. At Yorktown extensive pine-oak forests are common, along with extensive fields and lawn areas. Loblolly pine and various oaks are the dominant species. There are extensive areas of emergent and forested wetlands on the York River and at Wormley Pond.

Pine-hardwood forests, fields, emergent wetland, and forested wetlands span the length of the Colonial Parkway. Pine-hardwood forests also cover most of the Green Spring property with loblolly pine once again the dominant species. There are several large fields along the road that splits Green Spring. At Swann's Point, forested wetlands, upland forest of predominantly pine and hardwood, bald cypress (*Taxodium distichum*) stands, and emergent wetlands along the shoreline are present. The Cheatham Annex area is restricted to military use and managed under a special use permit. The mixed hardwood-pine environment provides areas for military training, wildlife habitats, and recreational opportunities, including fishing, and boating. There are also emergent and forested wetlands associated with the pond, ravines, and shoreline.

Fauna

As with vegetation, COLO supports a diverse body of wildlife species. Park officials have recorded the presence of 40 mammals, 225 birds, and 81 reptiles. Common species of mammals in the park include the eastern gray squirrel (*Sciurus carolinensis*), eastern cottontail (*Sylvilagus floridanus*), white-tailed deer (*Odocoileus virginianus*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), beaver (*Castor canadensis*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethica*), and Virginia opossum (*Didelphis virginiana*). Hawks, owls, Canada geese (*Branta canadensis*), and other waterfowl frequent the park, and bald eagles (*Haliaeetus leucocephalus*) have been sighted in several areas. The park is also home to several great blue heron (*Ardea herodias*) nesting colonies.

A 1987 USFWS survey of the park's Yorktown unit and Papermill Creek area of Williamsburg noted 19 species of fish which represented 15 genera and 12 families. Among the species cited were yellow perch (*Perca flavescens*), sunfish (*Lepomis* spp.), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and striped bass (*Morone saxatilis*).

In a 1991 study, the USFWS collected baseline fishery data for the Back River system in and around Jamestown Island. Thirty-six species of fish representing 18 families were collected. Results concluded that the Back River system served as an important nursery ground for several important commercial and recreational fishes, namely: striped bass, Atlantic croaker (*Micropogonias undulatus*), American eel (*Anquilla rastrata*), white perch (*Morone americana*),

and spot (*Leiostomus xanthurus*). Freshwater recreational fish such as largemouth bass, channel catfish (*Ictalurus punctatus*), yellow perch, and sunfish were also abundant, yet the salinity regime of the habitat precludes its viability as a productive spawning ground for freshwater fish.

Waters in and around the park are known to support eastern oysters (*Crassostrea virginica*), blue crab (*Callinectes sapidus*), hard clams (*Mercenaria mercenaria*), crayfish (Order Decapoda), perch, sunfish, bluegill, and bass.

Rare, Threatened, Endangered, Proposed, and Candidate Species

Protecting rare, threatened, or endangered species and those species which are candidates or are proposed for listing as endangered or threatened is an issue of special concern. The National Park Service contracted with the VA Dept. of Conservation and Recreation, Division of Natural Heritage, in 1988 to conduct a natural heritage inventory of all the NPS units in the state. According to the results of this survey, COLO has the second highest number of rare, threatened, and endangered species of all the National Park Service units in Virginia.

The Division of Natural Heritage previously surveyed the U.S. Navy's Cheatham Annex, including an adjacent area owned by COLO. The survey found that the Cheatham Annex area supports a wide variety of both common and rare animals and plants. The survey noted 8 species of turtles and 15 species of amphibians, 4 of which were salamanders. The Division of Natural Heritage identified the ravines around Cheatham Pond as habitat for rare plants.

Biological inventories were conducted for lands surrounding COLO. Important natural areas were identified within and adjacent to the park at Beaverdam Creek, Bracken's Pond, Cheatham Pond Ravines, Cub Creek, Jamestown Island, Jones Mill Pond, Powhatan Creek, Queen Creek, and Swann's Point.

Exotic Species

The park has numerous problems with invasive exotic plant species including Johnson grass (*Sorghum halapense*), Canadian thistle (*Carduus arvensis*), kudzu (*Pueraria lobata*), bamboo (*Phyllostachys aurea*), tree of heaven (*Ailanthus altissima*) and empress tree (*Paulownia tomentosa*).

METHODS

Collection of Information

Staff of the Virginia Department of Conservation and Recreation gathered a substantial amount of information to aid in development of natural area conservation plans for the natural areas in COLO. Existing knowledge regarding natural areas and topics pertinent to their conservation were studied. Recent aerial photographs, soil surveys, field notes from the inventory project, scientific publications, and conservation literature were included in this review. Additionally,

several scientific and conservation experts outside of the Division of Natural Heritage were consulted for their specialized knowledge relating to conservation of the natural areas.

Each natural area was visited at least once during the data collection phase of this project. During the visits, efforts were made to find the natural heritage resources originally documented by the 1993 inventory report, locate additional resources associated with the sites, assess the condition of the resources, determine stresses to the resources, and establish what protection and stewardship measures are necessary to insure the long-term survival of the resources.

Conservation Planning Principles

Standard natural heritage conservation planning guidelines were used for this project. Conservation plans are based mostly on protocols detailed in the *Preserve Selection and Design Manual* and other manuals and guidelines prepared by The Nature Conservancy and associated natural heritage network. Natural area conservation plans within this report use recently developed techniques outlined by The Nature Conservancy's Site Design Working Group in *Site Conservation Planning: Issues and Recommendations* (Baumgartner 1994).

Conservation planning involves the design of conservation zones, complete site information (e.g., natural heritage resources present, threats, ownership, existing protection), a protection strategy, and an assessment of stewardship needs. Because site conservation planning manuals are not widely available publications, a brief summary of conservation planning principles is presented below.

Threat Assessment

A simple threat assessment is used to identify and evaluate threats to the natural heritage resources of each natural area. Threats are distilled into stresses, sources, and effects. Stresses are the processes or events with direct deleterious ecological or physiological effects on the natural heritage resources or environmental conditions which negatively effect the natural heritage resource's persistence. Sources are the actions, agents, or entities from which the stresses are derived. Effects refer to the consequences of the stress acting on the natural heritage resource. An indication of the presence of the stress at the natural area (*i.e.*, current or potential) and the degree to which the stress threatens the natural heritage resources (*i.e.*, low, medium, high) is also provided. Conservation zones are developed based partially on the threat assessment. The threat assessment is intended to be comprehensive. Identification of a stress for a natural area accounts does not always mean that the stress is expected to occur, but that if such a stress did occur, it would threaten the natural heritage resource in question.

Conservation Zones

Principal components of any natural area conservation plan are the "conservation zones." Preliminary conservation planning boundaries (such as those presented in the 1993 inventory

report) are refined into conservation zones. Conservation zones are areas of land or water which address specific stresses or provide specific ecological needs for natural heritage resources at a site. Conservation zones may be independent, nested, or overlapped; very local to regional in scale; and may be simple or complicated. All depends upon the characteristics of the site and its natural heritage resources. Because of their variability, the extent and justification of each conservation zone in a natural area must be addressed separately in the discussion of that natural area. Table 3 provides some general definitions of the conservation zone types used in this document, but each natural area account should be consulted for specific justification and purpose of the conservation zones for that site. For this reason, conservation zones and the stresses they are meant to address are usually presented in a table format. Conservation zones are well suited for use in geographic information systems.

Conservation zones may address habitat or natural community needs, surface- or ground-water chemistry or flow, disturbance, pest species, or special management needs such as areas needed for the safe implementation of prescribed burns. Conservation zones should not be interpreted as regulatory zones or acquisition boundaries but as conservation tools to help guide the protection and stewardship of natural heritage resources.

The best and most current information is always used to guide the development of conservation zones. As knowledge of biological, geological, hydrological, social, and economic aspects of the natural area increases or changes, alterations or revisions in the conservation zones may become necessary to reflect the updated information. In some cases, sufficient information is not available. For example, the biology of some species is not well-understood due to a lack of scientific research. In these cases, conservation planning decisions are based upon what information is available and upon knowledge extrapolated from similar species, natural communities, and ecosystems.

Determination of compatible activities and uses within conservation zones is dependent upon biology of the natural heritage resources and the ecology of the natural area. Land use standards are specific to each site and may vary even among sites that support similar natural heritage resources if other environmental factors are different.

Natural Areas Protection

Many protection tools are available in Virginia for conservation of land containing natural heritage resources. Examples include acquisition, easements, natural area registry, conservation zoning, management agreements, and natural area dedication. Two of these protection tools, natural area registry and natural area management agreements, are most applicable to COLO's natural areas and are discussed in more detail below.

Table 3. Conservation Zones and NPS Designations.

Conservation Zones	
Zone Type	Purpose
Community	delineates the extent of rare or exemplary natural community occurrences at the site
Disturbance Buffer	protects disturbance-sensitive animals from agitation and disruption by human activities
Forested Buffer	protects habitat and community zones from edge-effect, sedimentation, invasive species, <i>etc.</i>
Ground-Water	protects quality and flow of ground-water recharge areas
Habitat	delineates the extent of rare species habitat
Streamside	protects in-stream habitats from alteration due to clearing or other stresses proximate to a stream
Surface-water	protects the quality and flow of surface-water
Watershed	a peripheral conservation zone (<i>i.e.</i> , not considered part of core natural area) including the watershed(s) in which the natural area is contained and intended to indicate an area in which large scale land-use changes may effect the viability of the natural area
NPS Designations for Land Protection	
Natural Zone	protection of natural resources and values; managed with a concern for fundamental ecological processes as well as individual species and features ("ecosystem management" or "biodiversity management" approach)
Natural Sub-Zone	sub-zone within context of park's larger historic zone managed for its natural resources (see above natural zone description)
Research Natural Area	prime examples of natural ecosystems and areas with significant genetic resources with values for long-term baseline and monitoring studies; areas are managed to provide the greatest possible protection for site integrity; <i>e.g.</i> , National Estuarine Research Reserves

The Virginia Registry of Natural Areas is a program developed to encourage voluntary conservation of significant lands in private and public ownership. Landowners of sites, or natural areas containing natural heritage resources play a crucial role in conservation of the Commonwealth's biodiversity. The program is operated by the Virginia Department of Conservation and Recreation. To be eligible for placement on the Registry, a natural area must support significant natural heritage resources. The decision to register belongs entirely to the landowner. Registry is a voluntary and non-binding agreement that may be terminated by either party at any time. The landowner who participates in the Registry commits to the following: to voluntarily preserve and protect natural heritage resources on their land to the best of their ability, to notify the Department of Conservation and Recreation of any potential threats to these resources, to notify DCR of intent to sell or transfer ownership of the property. In return, the landowner receives a plaque recognizing the land for its significant features, as well as management assistance from DCR at the landowner's request.

A Natural Area Management Agreement is a written contract between a landowner and the Virginia Department of Conservation and Recreation and sometimes other natural resource

agencies or organizations. The Agreement is designed to achieve specific conservation objectives related to the preservation of natural heritage resources. The Agreement clearly delineates the purpose of the contract, duration of the contract, and responsibilities. Management objectives are stated in the Agreement which are determined according to conservation goals of the landowner and the DCR. Management objectives are based on specific management needs of the natural heritage resources of the site. The contract is valid after it is signed by the landowner and the director of the DCR (plus any other agencies or organizations which are participating). The Agreement is a legal contract which may be canceled by either party following a 30-day notice.

Basics of Natural Areas Stewardship

Natural areas stewardship involves the administration and management of a natural area to assure long-term survival of the natural heritage resources it supports. The most important aspect of stewardship is determining compatible and incompatible land (and water) uses within a natural area. Which land uses are harmonious with resources will depend upon the type of natural heritage resource, the ecosystem, and the type and magnitude of the land use being considered. Allowable land uses will, therefore, vary from site to site. Certain forms of some land uses may be incompatible, while more environmentally sensitive methods of the same general activity may be compatible. For many natural heritage resources, some land uses may be only seasonally restricted.

Ecological management, another important component of natural areas stewardship, includes all activities on a natural area specifically intended to benefit, save, or maintain natural heritage resources. Examples of ecological management include prescribed burning, wildfire suppression, removal or planting of vegetation for habitat restoration, hydrologic restoration, installation of off-road vehicle barriers, and pest species control. Some natural heritage resources require intensive management, while many require no or little active management.

Probably one of the most common ecological management needs on COLO will be pest species control. **Pest species** are plants or animals which directly or indirectly threaten the viability of natural heritage resources or have the potential to do so. Most pest species are exotics or "aliens." Exotic species are those whose natural range does not include the site in question but which were intentionally or unintentionally introduced by humans. Often these exotic pest species become particularly invasive in disturbed areas. Examples of exotic pest species include eulalia (*Microstegium vimineum*), Japanese honeysuckle (*Lonicera japonica*), and kudzu vine. Some native species can also threaten natural heritage resources, especially in urbanizing areas. Beaver, white-tailed deer, and common reed (*Phragmites australis*) are examples of native species which can adversely affect natural heritage resources.

Stewardship also includes natural heritage resource monitoring activities. Natural heritage resource monitoring involves the periodic quantitative or qualitative study of natural heritage resources and their environment. The purpose of natural heritage resource monitoring is to

furnish long-term scientific data, to provide warnings of declines or damage to natural heritage resources, and to determine possible causes of such events. Additionally, natural heritage resource monitoring may document increases in rare species populations, track the recovery of disturbed ecosystems, and measure effectiveness of ecological management projects. Monitoring visits usually also include some analysis of the status of pest species and environmental conditions. Whether or not, in what manner, and how often a natural heritage resource is monitored is determined by its priority, sensitivity, threats, and staff availability.

Generally, natural heritage resource monitoring focuses on one or more of three purposes: assessment of population/community abundance or size, assessment of population/community condition, or assessment of population/community composition and structure. Natural heritage resource monitoring can be thought of as occurring on one of three levels (Table 4). Level I monitoring includes qualitative and semi-quantitative monitoring such as photography points and population size estimates to an order of magnitude. Level II monitoring involves quantitative monitoring of populations and communities such as counting the number of individual plants in a population every year. Level III monitoring is also quantitative and entails the detailed assessment of life history or demographic parameters. Level III monitoring often involves following marked individuals or plots over a period of time. Although the amount of monitoring effort increases with each increasing level, so does the detail of the information. It is easy to become overzealous with natural heritage resource monitoring and over-extend human resources or become engrossed in the collection of unnecessary or peripheral information that does not really address the objective of the monitoring project. Monitoring projects should be carefully designed to avoid unnecessary or extraneous efforts.

Table 4. Natural heritage resource monitoring Levels.

Level	Description
I	collection of qualitative or semi-quantitative information (<i>e.g.</i> , presence/absence, population estimate to an order of magnitude, photography points)
II	basic quantitative monitoring of populations or communities (<i>e.g.</i> , numbers, density, or frequency of individuals, distribution in age classes or size categories)
III	extensive quantitative monitoring of populations, communities, or individuals (<i>e.g.</i> measuring/tracking of marked individuals, measuring environmental variables simultaneous with population variables)

Use of photography points or photography plots is recommended as one natural heritage resource monitoring technique in each of the six sites. A photography point is simply a photograph taken from a fixed point towards a fixed direction or directions. The point from which the photograph is taken should be permanently marked such that the picture can be taken consistently from the same location year after year. All factors involved in the photography, such as camera type, lens type, film type, tripod height, date, and time of day, should be kept as consistent as possible from year to year. A photography plot is similar to a photography point except that the picture is taken looking down upon a permanent sampling area or plot. Again all factors, especially camera height, should remain constant from year to year. Photography points are normally used to document natural communities and species' habitats on a large scale. Photography plots are generally used to document individuals or groups of individuals and their immediate surroundings. Although not usually used in quantitative analysis, photography points and plots have several advantages in monitoring vegetation and other non-mobile factors. First, photography points and plots are easy and quick to perform. Second, they are an excellent supplement to quantitative data, providing a real world context to the numbers, tables, and graphs of quantitative monitoring. Third, photographs can be a real communications aid when trying to illustrate ecological changes in monitoring reports and presentations. Finally, photographs may detect changes that are missed by other types of monitoring.

Another part of stewardship is addressing the need for additional biological inventory or scientific research. In many natural areas, the true status of natural heritage resources is poorly understood, and the potential for additional natural heritage resources to be found has not been thoroughly examined. Additional biological inventory may be recommended for these situations. Some species, habitats, and natural communities are not well understood due to a lack of scientific research. Natural areas often provide an excellent setting for field research which may not only increase the general knowledge of the natural heritage resources and sensitive ecosystems but may also provide information directly pertinent to the site's conservation.

RESULTS AND RECOMMENDATIONS

A total of 21 occurrences of natural heritage resources occur on the six natural areas described in this report. Sixteen of these occurrences, or locations are within the boundaries of COLO and five are on adjacent lands. While these natural areas are primarily on COLO lands, some adjacent lands which support rare natural resources, or are necessary for long-term survival of natural heritage resources may be included. The natural areas contain five species of rare plants (seven occurrences), five species of rare animals (nine occurrences), and four rare or exemplary natural community types (five occurrences) (Table 6). A map of the study area with relative locations of the six natural areas is presented in Figure 8, and summary information regarding each natural area can be found in Table 5.

New Discoveries

Several new discoveries of natural heritage resources were made during the conservation planning project. A small occurrence of a chinkapin oak woodland (submesotrophic woodland), a rare natural community type, was found at Cheatham Annex. Two southern

Table 5. Natural Areas of Colonial National Historical Park.

Natural Area	Biodiversity Rank	Size acres (hectares)	Natural Heritage Resources
Beaverdam Creek	B4	676 (273)	Florida Adder's-Mouth Northern Spring Sideswimmer Spanish Moss Great Egret Great Blue Heron
Bracken's Pond	B4	194 (78)	Fibrous Bladderwort
Cheatham Ravines	B4	493 (200)	Chinkapin Oak Woodland Loesel's Twayblade Mountain Camellia
Jamestown Island	B4	809 (327)	Bald Eagle Least Bittern Great Blue Heron
Queen Creek	B5	598 (242)	Tidal Brackish Marsh Tidal Freshwater Marsh Southern Mixed Hardwood Forest
Swann's Point	B5	572 (231)	Bald Eagle Great Blue Heron

**Table 6. Natural Heritage Resources of Colonial National Historical Park's Natural Areas
(Inventory data, Ludwig *et al.* (1993), plus subsequent 1994 monitoring data)**

Common Name	Scientific Name	Number of Occurrences	
		Within Park	Adjacent to Park
PLANTS			
Fibrous Bladderwort	<i>Utricularia fibrosa</i>	1	0
Florida Adder's-Mouth	<i>Malaxis spicata</i>	1	0
Loesel's Twayblade	<i>Liparis loeselii</i>	3	0
Mountain Camellia	<i>Stewartia ovata</i>	1	0
Spanish Moss	<i>Tillandsia usneoides</i>	0	1
ANIMALS			
Bald Eagle	<i>Haliaeetus leucocephalus</i>	2	0
Great Blue Heron	<i>Ardea herodias</i>	3	0
Great Egret	<i>Casmerodius albus</i>	2	0
Least Bittern	<i>Ixobrychus exilis</i>	1	0
Northern Spring Sideswimmer	<i>Gammarus pseudolimnaeus</i>	1	0
NATURAL COMMUNITIES			
Chinkapin Oak Woodland	Submesotrophic Woodland	1	0
Tidal Brackish Marsh	Mid-Height Herbaceous Palustrine Wetland	0	1
Tidal Freshwater Marsh	Mid-Height Herbaceous Palustrine Wetland	0	1
Southern Mixed Hardwood Forest	Submesotrophic Forest	0	2

TOTAL

16

5

mixed hardwood forests (submesotrophic forest), a common natural community type, were added to the list of natural heritage resources at Queen Creek based on information indicating that these forest stands have local biodiversity significance. A newly discovered great blue heron colony at Swann's Point (mentioned briefly in the inventory report) also has been added.

Changes in Ranks and Status

Several changes to rarity ranks of natural heritage resources found in or near COLO have occurred since the publication of the inventory report. The northern spring sideswimmer (*Gammarus pseudolimnaeus*) has been re-ranked from G5/S1 to G5/S2. Great blue heron (*Ardea herodias*) has been changed to a G5/S3S4? from a G5/S3. Great blue heron may be moved to the animal watchlist. The southern twayblade (*Listera australis*), which was reported as G4/S2S3 in the inventory report, is now G4/S3. The species has been removed from the Rare Plant List and placed on the plant watchlist. The global rank of the bald eagle has been moved from G3 to G4. The federal legal status of this species has also been reclassified from endangered to threatened. Although still officially ranked at G3G4/S2, it is anticipated that Florida adder's-mouth (*Malaxis spicata*) will be changed to G3G4/S3 and moved to the plant watchlist with the next revision of the Rare Plant List.

A few natural heritage resource occurrence rank changes were also instituted during the conservation planning study. At Beaverdam Creek, the great egret (*Casmerodias albus*) occurrence rank changed from U to B and the great blue heron occurrence rank went from U to A. Based on new information, the great blue heron occurrence rank at Jamestown Island has also been changed from D to C. The rank of the Queen Creek herbaceous wetland is now C, down from a B. At Jamestown Island the southern twayblade was dropped due to the re-ranking of that species and its placement on the plant watchlist.

The above changes in rarity ranks, occurrence ranks, and additions and deletions of natural heritage resources have resulted in changes of the biodiversity ranks for all six of the natural areas: Beaverdam Creek B5 to B4, Bracken's Pond B5 to B4, Jamestown Island B2 to B4, Queen Creek B4 to B5, Swann's Point B3 to B5, and Cheatham Ravines (formerly Cheatham Pond Ravines, Cub Creek, and Jones Mill Pond) B5 to B4.

General Recommendations

The six natural areas of this study represent sites of local and regional biodiversity significance either completely or partially influenced by management actions of COLO. It is **recommended** that COLO:

continue to vigorously pursue protection and appropriate stewardship of these sites in order to preserve the natural heritage resources they contain,

incorporate the specific protection and stewardship recommendations for each site into Colonial National Historical Park's planning documents,

pursue placement of all six sites on the Virginia Registry of Natural Areas,

continue to include the Virginia Department of Conservation and Recreation and other state and federal natural resource agencies in all planning and project review activities related to the natural areas.

Tables 7, 8, and 9 provide summaries of protection, management, and monitoring recommendations, respectively, for each site. Detailed protection, monitoring, and management recommendations can be found in the site account for each natural area.

Table 7. Summary of Protection Recommendations.

Natural Area	Protection Recommendations
Beaverdam Creek	integrate protection and management recommendations into COLO planning documents management agreement among COLO, DCR, VDGIF, and City of Newport News placement on Virginia Registry of Natural Areas
Bracken's Pond	integrate protection and management recommendations into COLO planning documents management agreement among COLO, DCR, and YNWS placement on Virginia Registry of Natural Areas
Cheatham Ravines	integrate protection and management recommendations into COLO planning documents placement on Virginia Registry of Natural Areas
Jamestown Island	integrate protection and management recommendations into COLO planning documents approach VDGIF and USFWS regarding bald eagle management placement on Virginia Registry of Natural Areas
Queen Creek	integrate protection and management recommendations into COLO planning documents management agreement among DCR and major property holders placement on Virginia Registry of Natural Areas
Swann's Point	integrate protection and management recommendations into COLO planning documents approach VDGIF and USFWS regarding bald eagle management placement on Virginia Registry of Natural Areas

Table 8. Summary of Management Recommendations.

Natural Area	Management Recommendations
Beaverdam Creek	compliance with land use recommendations within the various conservation zones periodically assess beaver and deer impacts; ameliorate, if necessary periodically assess invasive plant impacts; ameliorate, if necessary
Bracken's Pond	compliance with land use recommendations within the various conservation zones periodically assess beaver impacts; ameliorate, if necessary periodically assess invasive plant impacts; ameliorate, if necessary
Cheatham Ravines	compliance with land use recommendations within the various conservation zones periodically assess deer impacts; ameliorate, if necessary periodically assess invasive plant impacts; ameliorate, if necessary
Jamestown Island	compliance with land use recommendations within the various conservation zones periodically assess invasive species impacts; ameliorate, if necessary
Queen Creek	compliance with land use recommendations within the various conservation zones periodically assess deer impacts; ameliorate, if necessary periodically assess invasive plant impacts; ameliorate, if necessary
Swann's Point	compliance with land use recommendations within the various conservation zones

Table 9. Summary of Natural Heritage Resource Monitoring Recommendations*.

Arranged by Site	
Natural Area	Monitoring Recommendations
Beaverdam Creek	Florida adder's-mouth and Spanish moss - search habitat, note abundance and condition, map, check pest species, photography points northern spring sideswimmer - search, collect specimens, note condition of habitat, map, photo points great blue herons and great egrets - VDGIF survey, note number pairs, map colony location
Bracken's Pond	fibrous bladderwort - search, note abundance and condition, assess beaver activity, photo points
Cheatham Ravines	Loesel's twayblade and mountain camellia - search, note abundance and condition, map, assess pest species, photo points chinkapin oak woodland - relevé with photo points
Jamestown Island	great blue heron and bald eagle - VDGIF aerial survey, check for nesting activity, map colony/nest, note production least bittern - search, note numbers seen/heard, note any nests found or nesting behavior observed
Queen Creek	tidal freshwater and brackish marsh and southern mixed hardwood forest - relevés with photo points

**Table 9 - Summary of Natural Heritage Resource Monitoring Recommendations* continued:
Arranged by Month**

Month	Natural Heritage Resource	Natural Area(s)
February	Bald Eagle	Jamestown Island, Swann's Point
February	Bald Eagle	Jamestown Island, Swann's Point
March	Great Blue Heron Great Egret	Beaverdam Creek, Jamestown Island, Swann's Point Beaverdam Creek
June	Loesel's Twayblade Spanish Moss	Cheatham Ravines Beaverdam Creek
July	Fibrous Bladderwort Least Bittern Mountain Camellia	Bracken's Pond Jamestown Island Cheatham Ravines
August	Chinkapin Oak Woodland Florida Adder's-Mouth Southern Mixed Hardwood Forest Tidal Freshwater and Brackish Marsh	Cheatham Ravines Beaverdam Creek Queen Creek Queen Creek
October	Northern Spring Sideswimmer	Beaverdam Creek

*note that general pest species monitoring recommendations are in Table 8

NATURAL AREA DESCRIPTIONS

Each natural area has a description that furnishes information on the size, biodiversity rank, location, description, natural heritage resources, and ownership. Each natural area description includes an assessment of threats facing the site, a map, table, and discussion regarding the conservation zones designed to address those stresses, as well as recommendations for protection and stewardship. Conservation zones should not be interpreted as regulatory or acquisition boundaries, but as conservation tools to help guide the protection and stewardship of natural heritage resources.

Natural Area Description Format

The description of each natural area is presented in a standard format which is outlined in Table 10 and explained below.

Table 10. Natural Area Description Format.
Site Name Size Biodiversity Rank Location General Description Natural Heritage Resources Threat Assessment Conservation Zones Ownership Protection Recommendations Natural Heritage Resource Monitoring Recommendations Management Recommendations

Size

The total area in acres/hectares of all core conservation zones overlayed together is provided. This figure does not include the area of peripheral conservation zones (watershed conservation zones, in the case of this study). Acreage has been calculated using a hand-operated planimeter on 1:24,000 scale U.S. Geologic Survey topographic maps.

Biodiversity Rank

The overall significance of the natural area in terms of its natural heritage resources is represented on a five point scale. Derivation of B ranks is explained in the introduction of this document. Changes in B ranks from the inventory report to this document are noted in the results section.

Location

The city or county and U.S. Geologic Survey 7.5 minute quadrangle in which the site occurs is provided.

General Description

A brief narrative regarding the natural area is presented here. This section usually includes information on topography, vegetation, wetlands and watercourses, geology, soils, historic and current land use within the site, and land use surrounding the site. Geology information is taken from *Geologic Map of Virginia* (DMME 1993), *Geologic Map of Yorktown Quadrangle* (Johnson 1971), and *Geology and Mineral Resources of the Brandon and Norge Quadrangles* (Johnson and Berquist 1989). Soils information is taken from *Soil Survey of James City and York Counties and the City of Williamsburg, Virginia* (Hodges *et al.* 1985). Nonpoint source pollution information is taken from *Virginia Nonpoint Source Pollution Watershed Assessment Report* (DCR 1993). Water quality data is derived from *Virginia Water Quality Assessment for 1994* (VDEQ 1994)

Natural Heritage Resources

This section presents a synopsis of the natural heritage resources found on the natural area. Information usually includes common name, taxonomic affiliation, rangewide and state rarity status, global and state distribution, a brief description, and critical ecological needs. A table summarizing information regarding natural heritage resources of the site, including common name, scientific name, global rarity rank, state rarity rank, federal legal status, state legal status, and occurrence rank is also included.

Threat Assessment

Threats facing natural heritage resources of the natural area are addressed here. For each natural heritage resource, stresses, effects of the stress, and the source of the stress are identified. A table is included which lists stresses, effects, presence (current/potential), degree (low, mod., high), and source for each natural heritage resource. For current stress, degree refers to level of threat to the continued existence of the natural heritage resource occurrence. If the stress is listed

as potential, degree refers to the probability of that stress occurring. Furthermore, since these natural areas occur both on and adjacent to park property, many of the threats may have their source outside the park. The threat assessment is intended to be comprehensive. All possible threats are addressed, even though some are not expected to occur (especially on park property).

Conservation Zones

This section discusses the natural area's conservation zones including their extent and purpose. A conservation zone table organized by natural heritage resources, lists the zone name, extent, compatible and incompatible uses, and the stresses the zone is designed to attenuate.

Ownership

Basic ownership information regarding the natural area including proportion of site owned by the park is related here. To preserve rights to privacy, detailed information regarding private landowners is withheld.

Protection Recommendations

This section discusses existing and recommended protection of the natural area and its natural heritage resources. To preserve rights to privacy, protection strategies with private landowners are generalized.

Natural Heritage Resource Monitoring Recommendations

This section details recommendations for natural heritage resource monitoring of the natural heritage resources. An accompanying table organized by natural heritage resource shows the level of monitoring, methods, frequency, and timing.

Management Recommendations

Recommendations for further inventory, compatible and incompatible land uses, research, and active ecological management are provided here.

Map

Each natural area description includes a map of the natural area showing conservation zones. Because of potentially missing or incorrect information on the base maps and their relatively large scale, a small margin for error may exist with many of the conservation zone boundaries. Fine tuning of boundaries on the ground can be accomplished through site visits as necessary.

Beaverdam Creek Natural Area

Size: 676 ac (274 ha)

Biodiversity Rank: B4

Location: York County and City of Newport News
Yorktown 7.5 minute Quadrangle

General Description:

Beaverdam Creek Natural Area includes several springs at Washington's Headquarters, the lower 1 1/4 mile reach of Beaverdam Creek, portions of three tributaries (Baptist Run and two unnamed creeks) along this reach, the upper 1/3 mile of the Lee Hall Reservoir, and a substantial amount of surrounding forested wetland, bottomland, and upland forests. The area supports two rare plant species, a bird nesting colony, and a rare crustacean.

Springs at Washington's headquarters discharge cool ground water from the shallow aquifer nearly year round. Beaverdam Creek itself is a sluggish non-tidal stream fed by a combination of springs and surface runoff. Part of the stream in the natural area has been flooded by the reservoir downstream. There is evidence of beaver activity in the natural area. Some tributaries to Beaverdam Creek are dry during parts of some years.

The entire natural area, except areas of open water, is forested. Forest stands on the site include forested wetlands, bottomlands, and uplands. Forested wetlands and bottomlands are dominated by green ash (*Fraxinus pennsylvanica*) and red maple. An open forested wetland along the lower reaches of the creek contains significant amounts of broad-leaved cattails (*Typha latifolia*), wax myrtle (*Myrica cerifera*), and smartweeds (*Polygonum* sp.). Upland forests are mostly mixed pine-hardwood dominated by white oak (*Quercus alba*), hickories (*Carya* sp.), and loblolly pine (*Pinus taeda*) with flowering dogwood (*Cornus florida*) and American holly (*Ilex opaca*) being the common understory species.

Surficial deposits of the Beaverdam Creek Natural Area are Windsor, Chuckatuck, Shirley, and Holocene paludal and alluvial deposits. In addition, thin colluvial and sinkhole deposits are common in the area. The Yorktown Formation is composed of biofragmental sands and whole shells. The upper Yorktown is commonly weathered to a reddish brown clay and is overlain by the Windsor in the northwestern part of Beaverdam Creek Natural Area. The Windsor is comprised of a fluvial-estuarine quartzose sand near the base and a clayey silty fine sand at the surface. The Chuckatuck is similar in composition and texture but at a lower elevation under the Grafton plain. The Shirley Formation of middle Pleistocene age crops out in both sides of Beaverdam Creek between the Kingsmill scarp. The lower part of the Shirley is a gravelly sand overlain by a sand, the upper part is a thick estuarine mud. Holocene deposits consist of organic-rich silt and fine sand deposited on floodplains and forested wetlands at the head of the reservoir.

Ground water issuing from the upper formation is acidic and ground water from the Yorktown is circumneutral.

The shallow ground-water system in the area consists of three layered aquifers separated by confining units. The upper-most aquifer, known as the Columbia aquifer, is the unconfined water-table aquifer. The Columbia aquifer recharges locally by infiltration and discharges into the York River, down through confining layers to the underlying aquifers, and to the surface via springs and seeps. It is the surface discharge of the Columbia aquifer that forms the springs at Washington's Headquarters.

Soils in the lower forested wetland around and near the reservoir are a silty clay. Remaining forested wetland and bottomlands consist of nearly level, poorly-drained silt loams. Soils sloping from the upland plain to the bottomlands include highly erodible fine sandy loams. The nearly-level uplands are mostly fine sandy loam with a minor component of silt loam.

Current land uses within the primary conservation area include park land and water supply protection. Two paved roads traverse the northern portion of the natural area. Trails are found throughout the natural area. A parking and interpretive area lies south of the springs. Access to the parking area is provided by a paved road which fords a tributary to Beaverdam Creek. Beaverdam Creek Natural Area is surrounded by predominately forested lands. These forests are also maintained as park land and water supply protection areas. A golf course occupies land south and east of the site and residential development predominates as close as 3/4 mile to the east. Major historic land uses of the natural area and vicinity were agriculture and silvicultural. Battles of both the Revolutionary and Civil Wars were fought in the vicinity, and Civil War earthworks can still be seen in some parts of the natural area. Much of the land within the natural area has been disturbed by impoundment, past timber harvest, beaver activity, and past agriculture.

The watershed in which Beaverdam Creek Natural Area is contained is rated as medium priority for agricultural nonpoint source pollution potential and as high priority statewide for urban nonpoint source pollution potential (VDCR 1993). Elevated nutrient levels are documented from the watershed (VDEQ 1994).

Natural Heritage Resources

A summary of natural heritage resources from Beaverdam Creek Natural Area is shown in Table 11. **Florida adder's-mouth** (*Malaxis spicata*; photo-Appendix A) has been documented from Beaverdam Creek through the discovery of a single individual in 1990. Counts of emergent plants can underestimate populations of Florida adder's-mouth because individuals of this species may remain dormant in the soil as tubers for extended periods of time. Additional surveys may locate more plants in the future, but no plants were found during searches made in 1992 and 1993.

Table 11. Natural Heritage Resources of Beaverdam Creek.

Common Name	Scientific Name	Global Rarity Rank	State Rarity Rank	US Legal Status	VA Legal Status	NHR O* Rank
Florida Adder's-Mouth	<i>Malaxis spicata</i>	G3G4	S2	none	none	B
Great Blue Heron	<i>Ardea herodias</i>	G5	S3	none	none	A
Great Egret	<i>Casmerodias alba</i>	G5	SB2N4	none	none	B
Northern Spring Sideswimmer	<i>Gammarus pseudolimnaeus</i>	G5	S2	none	none	B
Spanish Moss**	<i>Tillandsia usneoides</i>	G5	S2	none	none	U

* natural heritage resource occurrence rank ** occurrence not within COLO boundary

Florida adder's-mouth, an inconspicuous herb in the orchid family, is very rare in Virginia. It is currently known from fifteen sites in four coastal plain counties of the state. The species is rare to uncommon throughout its range which is Virginia to Florida.

The Florida adder's-mouth grows two to six inches tall and sprouts one or two oval leaves from a bulbous base. This perennial species bears a few to many small white flowers with orange "lips" on a central stalk in middle to late summer. Florida adder's-mouth is a plant of moist, calcareous, shaded soils and is usually found along stream banks, forested wetland margins, or wet mossy areas.

Great blue herons (*Ardea herodias*; photo-Appendix A) and **great egrets** (*Casmerodius albus*; photo-Appendix A) nest in one of the largest heron nesting colonies in Virginia along Beaverdam Creek. The colony supports up to 500 pair of the these two species. An aerial survey over the colony by VDGIF observed 405 great blue heron pairs and 65 great egret pairs in the spring of 1994. Colonial nesting birds pack large numbers of nests into a few, small areas. This makes entire populations vulnerable to a single disturbance. For nesting, both species require tall trees in a substantial, remote woodland close to water. Peak nesting times for both species are March through May, but colonies are frequently active from February through July. Nests of both species are typically rickety stick platforms. A clutch size of three or four is common for both species. Herons and egrets also require shallow water habitats for foraging with an ample supply of fish, amphibians, and crustaceans that form the core of their diet. Since herons may eventually kill the trees in which they nest, colony boundaries tend to slowly migrate across the landscape (the Beaverdam Creek colony has migrated from City of Newport News property onto COLO property). This makes the availability of additional nesting habitat around a colony essential to its continued occupation.

Great blue herons are the largest wading bird found in Virginia. Great blue herons are tall, long-necked, long-legged birds with a blue-gray back and a spear-like beak. The species is a year-

round resident in Virginia. Great blue herons are quite widespread in eastern Virginia and populations appear to be increasing. This has put the species' status as a natural heritage resource under some deliberation. Although individuals are frequently encountered in the wetlands of eastern Virginia, the species' habitat is limited and threatened by development pressures. Additionally, the species nests colonial nesting habits puts more individuals at risk to single disturbances.

Great egrets are similar in build to great blue herons, but are slightly smaller overall and have all white plumage, black legs, and yellow beaks. Great egrets are near the northern edge of their range in Virginia where they are migratory, although scattered individuals can be found in southeast Virginia and the Eastern Shore year-round. Great egrets are considered very rare in Virginia as a breeding species because they are known from only approximately ten colonies in five counties.

The **northern spring sideswimmer** (*Gammarus pseudolimnaeus*; photo-Appendix A) is a type of crustacean known as an amphipod which resembles a small shrimp in appearance. Also known as scuds, sideswimmers get their name from their habit of skittering about their aquatic habitats on their side. The northern spring sideswimmer is usually found in unpolluted, clear, cool streamlets often containing leaf litter or aquatic vegetation. They are quite frequently associated with ground-water springs or seeps such as the springs at Washington's Headquarters. Northern spring sideswimmers are omnivorous scavengers and detritus feeders.

A healthy population of northern spring sideswimmers inhabits the streamlets fed by the Washington' Headquarters springs. Northern spring sideswimmers are very common throughout the principal portion of their range which includes the Great Lake and east-central states and provinces. Washington's Headquarters was the first and, for many years, the only known site for the species in Virginia. Additional surveys by DCR biologists have discovered populations of the species at several sites on the Lower Peninsula (including the Yorktown Creek area of COLO). These discoveries have led to the down-ranking of the species from S1 to S2. The Virginia populations are severely disjunct from the principal range and may be genetically distinct.

Spanish moss (*Tillandsia usneoides*; photo-Appendix A) is a common plant in southeastern North America and into Central and South America. Historic records indicate the species extended north into Maryland, but southeast Virginia represents the northern limit of the species' current range. Spanish moss is known from only twelve sites in five southeastern Virginia counties. The species is considered very rare in the Commonwealth not only because of the small number of locations where it grows, but also due to its very limited distribution in the state. A small population of Spanish moss has been observed in the lower forested wetland of Beaverdam Creek.

Spanish moss is a pale plant of the pineapple family which has wiry branches and stringy leaves. The plant hangs in clumps from the branches and leaves of trees in wet areas. Because it is a plant which grows on other plants, the species is termed "epiphytic." Blooming of the inconspicuous greenish to yellowish flowers peaks in June, but the species may flower throughout the growing season.

Threat Assessment

A threat assessment for Beaverdam Creek is presented in Table 12. Primary threats to the Florida adder's-mouth are altered surface-water levels and pest species¹. Beaver activity in the area could cause a rise in the water level or another significant alteration to the surface-water regime leading to saturation or flooding of the rare plant habitat. Reservoir enlargement, culvert construction, or development of the vicinity (causing increased runoff, decreased infiltration) could have the same effect. Other than beaver, the pest species of chief concern include white-tailed deer and eulalia. Colonial National Historical Park and Newport News Park have large deer populations; deer browse could be a serious threat to this small rare plant population. Eulalia, an exotic pest plant, is already present in the area and could eliminate the rare plant via interspecific competition. This would be especially likely if light gaps, caused either by cutting or by wind-throws, increased the sunlight in the rare orchid habitat. Since the species is somewhat shade tolerant, light gaps can allow eulalia to become established in an area from which it can then spread rapidly into forest habitats. Clearing² would also be a threat to the Florida adder's-mouth, but it is not expected to occur on COLO property.

Direct destruction of their habitat from diversion or disturbance of the streamlet would devastate the amphipod fauna of the streamlet. Northern spring sideswimmers are dependent on oxygen rich, clear, clean water with detritus (such as leaf litter) or aquatic vegetation. Therefore, clearing of woodland adjacent to the sideswimmers' streamlets may extirpate a population by reducing the amount of leaf litter input to the streamlet, allowing the water temperature to rise from increased exposure to sunlight (warmer water holds less oxygen), and increasing erosion of the stream banks and thus sedimentation of the water. Similar effects could be experienced if the

1. For purposes of this document, "pest species" is used to refer to any species which may produce undesirable effects on natural heritage resources. For example, pest species may include invasive, non-native (or "exotic") plants, such as Japanese honeysuckle or tree-of-heaven, or may include native but potentially harmful animals, such as southern pine beetles or white-tailed deer.

2. For purposes of this document, "clearing" refers to any removal of canopy, understory, or herbaceous vegetation. For example, clearing includes removal of all vegetation to facilitate construction of new roads, buildings, or other structures; removal of all or certain trees for commercial purposes; or removal of selected stands of trees for pest control.

surrounding woodland is defoliated by disease or pests. Although the crustaceans can burrow into the substrate to wait out temporary dry periods in the streamlet, long-term or permanent decreases in the streamlet flow, as from water withdrawal, will lead to extirpation of the population. Withdrawal of ground water or alteration of recharge areas such that the amount of infiltration is significantly changed would have similar results. Flooding of a streamlet by impoundment or a culvert would increase access to the sideswimmers by their primary predators, fish, as well as alter the aquatic habitat enough to possibly eliminate the population. Ground water flowing from the springs is characterized by high concentrations of calcium, bicarbonate, and iron with a pH close to neutral. Sideswimmers are very sensitive to changes in this chemistry. Additionally, contamination of the ground water by metals (*e.g.*, mercury), toxic organic compounds (*e.g.*, pesticides, petroleum), nutrients (from leaching fertilizer or septic systems), or pH altering chemicals could prove fatal to the amphipod fauna. It is not known at this time if the parking area, its access road, and the stream ford are affecting the northern spring sideswimmer population detrimentally or if they are benign. Further study on the issue is warranted.

Principle threats to the Spanish moss are collecting and loss of host trees and habitat. These threats appear to be very minimal at this time.

The principal threat to the great blue herons and great egrets is disturbance. Nesting herons and egrets can be extremely sensitive to disturbance from human activity, especially during critical courtship, nest-building, and egg-laying stages of nesting. A single disturbance can cause failure of the entire colony. Forest management activities, construction work, off-road vehicles and, to a lesser degree, hikers, bikers, and horseback riders are all activities which have caused problems for heron colonies in the past. The colony at Beaverdam Creek is not in a high use area, but disturbance from visitors of COLO or Newport News Park still poses a substantial threat. Disturbance to foraging herons and egrets can also be a threat. Foraging herons and egrets which are repeatedly flushed from foraging areas may have trouble acquiring enough energy to support themselves and their young. Destruction of nesting or foraging habitat by timber harvest or development may also be a threat if land use in either managed area changes.

A general scale, landscape based threat to the natural area is increased development and major road construction in the vicinity but outside the periphery of the natural area. In addition to loss of potential habitat, encroaching peripheral development may cause surface and ground-water problems in the sensitive area, increase the amount of abrupt ecotone (the "edge effect"), and further fragment and isolate this natural area from other natural areas.

Conservation Zones

Beaverdam Creek Natural Area has a moderately complex set of conservation zones (Table 13 and Figure 9). Habitat conservation zone A includes the known station for Florida adder's-mouth and a substantial area of the surrounding habitat which may potentially support the species.

Habitat conservation zone B consists of the stream bottoms near Washington's Headquarters from the spring heads to the access road ford which represents the habitat of the northern spring sideswimmer. The nesting colony of great blue herons and great egrets is encompassed by habitat conservation zone C while habitat conservation zone D includes some foraging

Table 12. Threat assessment for Beaverdam Creek.

Stress: Effect	Presence: Degree	Source
Florida Adder's-Mouth		
surface-water flow alteration: decreased population vigor, loss of habitat	current:medium	beaver activity; reservoir enlargement; development of vicinity
displacement: direct displacement via competition or indirect displacement via habitat alteration	current:medium	pest plant invasion (eulalia already in vicinity)
herbivory: reduced vigor; loss of individuals, populations; failure to reproduce	current:medium	deer browse
collection, trampling, direct loss of individuals; significant reduction of population	current:low	hikers; collectors
clearing: loss of habitat; invasion by shade intolerant plant species	potential:low	construction, maintenance of park trails; pest species control efforts
surface-water chemistry alteration: change in nutrient cycle; sedimentation of plants and habitat; toxic contamination resulting in death or reduced vigor of rare plants	potential:low	development or clearing of vicinity; chemical spills or leaks; wastewater discharge
Northern Spring Sideswimmer		
surface-water chemistry alteration: sedimentation, nutrient loading, toxic contamination of habitat resulting in death or reduced vigor of rare crustaceans	current:low(?)	access road, ford, parking lot, trails, lawn; further clearing leading to erosion and warming of stream water
ground-water chemistry alteration: nutrients, toxics in ground water, change in water chemistry beyond tolerance limits of species	potential:low	septic systems; fertilizer/pesticide use; leaking storage tanks, pipeline; chemical spills, leaks in recharge area
streamside clearing/conversion: alteration, loss of habitat; reduced vigor or extirpation of population	potential:low	clearing, construction along streams; forest pestilence and disease
ground-water flow alteration: loss of habitat; predation	potential:low	water withdrawal; ditching(?); increased impervious surface area
surface-water flow alteration: loss of habitat; predation	potential:low	beaver activity; culvert construction, impoundment
Spanish Moss		
collection: direct loss of individuals; significant reduction of population	current:low	collectors
destruction of host trees: loss of microhabitat	potential:low	cutting for trail construction, maintenance; timber harvest; enlargement of reservoir (causing higher water levels which kill trees)
Great Blue Heron and Great Egret		
disturbance: failure of colony; abandonment of site; interference with foraging	current:medium	hikers; bikers; ORV's
destruction of nest trees and habitat: failure of colony; abandonment of site	potential: low(?)	clearing for trail or road construction, pest control, development

habitat for herons and egrets (birds probably also forage off-site) as well as the habitat of Spanish moss.

The streamside conservation zone protects the sideswimmer habitat from alteration due to streamside clearing. Surface-water conservation zones A and B surround habitat conservation zones A and B, respectively, encompassing 100 yd (91 m) wide forested buffer areas. These zones help address surface-water chemistry and flow threats to the Florida adder's-mouth and northern spring sideswimmer. A ground-water conservation zone is delineated around the northern spring sideswimmer station. This zone encompasses probable ground-water recharge areas for the springs which feed the streamlets in which the sideswimmers live. The boundary of this zone is drawn approximately at the height-of-land. No ground-water flow studies have been completed for these springs; further study would be needed to accurately map the actual recharge areas for the springs.

Disturbance conservation zone A is a 1,000 ft (300 m) wide area around the nesting colony designed to protect it from disturbance. Similarly, disturbance conservation zone B includes 100 ft (30 m) of forest buffer around the heron and egret foraging area designed to help screen foraging birds from disruptive human activities.

A peripheral conservation zone, the watershed conservation zone (Figure 10), includes all of the surface watershed upstream of the dam of the Lee Hall Reservoir. This peripheral zone is not part of the core conservation area and indicates an area in which land use changes may affect surface-water flow or chemistry or may affect heron and egret nesting and foraging.

Ownership

Beaverdam Creek Natural Area is entirely in public ownership. Three-hundred ninety-three ac (159 ha or 58%) of the area are owned by the National Park Service. The remaining 283 ac (114 ha or 42%) are owned by the City of Newport News.

Protection Recommendations

Beaverdam Creek Natural Area is already moderately well protected by virtue of its ownership by two public agencies, COLO and Newport News Waterworks Department, which manage the property for its natural resources. The great blue herons, great egrets, and their nests and nest trees are protected from direct destruction or disturbance by the Migratory Bird Treaty Act. The wetland habitats within the natural area also receive some protection from the Federal Clean Water Act which regulates alterations of many wetlands. Wetland areas of the natural area outside of COLO's ownership are also subject to state and local wetlands and related regulations (*e.g.*, Chesapeake Bay Regulations). Projects proposed, funded, or permitted by a federal agency (such as COLO) require environmental review under the National Environmental Policy Act.

Table 13. Conservation Zones for Beaverdam Creek.

Zone	Extent	Compatible, Incompatible Uses	Stress(es)
Florida Adder's-Mouth: habitat A	known rare plant station plus substantial habitat	no direct or indirect alteration; do not encourage visitation	exotic pest plant invasion; collecting, trampling; clearing
surface-water	100 yd (91 m) forested buffer upslope of habitat zone	no cutting trees, clearing, construction, roads, trails, buildings	altered surface-water chemistry
watershed	Lee Hall Reservoir watershed	carefully consider activities which may effect surface-water flow or chemistry (<i>e.g.</i> , reservoir enlargement, development, upstream water withdrawal)	altered surface-water flow and chemistry; herbivory
Northern Spring Sideswimmer: habitat B	streamlets where species is found from springheads to ford	no water withdrawal upstream of ford; discourage disturbances of stream bottom banks	streamside clearing and conversion; surface-water chemistry and flow alteration
streamside	100 ft (30 m) on either side of habitat B zone	no clearing, construction, trails, <i>etc.</i>	streamside clearing
surface-water	100 yd (91 m) forested buffer upslope of streamlets	no additional roads, trails, clearing, <i>etc.</i>	surface-water flow and chemistry alteration
ground-water	includes probable recharge area for shallow aquifer discharging at springs	no new storage tanks; remedial action may be necessary for any existing storage tanks; no shallow ground-water withdrawal; minimize increase in impervious surface area	ground-water chemistry and flow alteration
Spanish Moss: habitat D	forested wetland; known site and potential habitat for rare plant	discourage collection; no direct or indirect alteration of habitat	collection; destruction of host trees
watershed	Lee Hall Reservoir watershed	carefully consider activities which may affect surface-water chemistry and flow (<i>e.g.</i> , major road construction)	destruction of host trees
Great Blue Heron & Great Egret: habitat C	encompasses nesting colony plus small amount additional peripheral woodland for colony movement	no clearing, construction, building, roads, trails; no access into zone Feb. - Aug. except for research and monitoring	disturbance; destruction of nest trees and habitat
habitat D	open forested wetland and shallow waters providing some foraging habitat (same extent as Spanish moss habitat)	no roads, buildings, timber harvest, major construction; existing nature trail okay; encourage visitors not to disturb foraging herons, egrets	disturbance
disturbance A	1000 ft (300 m) around habitat C	no access Feb.- Aug. except research and monitoring	disturbance
disturbance B	100 ft (30 m) around habitat D	no clearing, additional trail or road construction	destruction of foraging habitat; disturbance of foraging birds
watershed	Lee Hall Reservoir watershed	carefully consider activities which may affect NHR's	disturbance; destruction of habitat

Because of the multiple ownership and variety of natural heritage resources on the natural area, a management agreement among Newport News Park, Newport News Waterworks, COLO, VDGIF, and DCR is recommended. The agreement should outline land use, management practices, and monitoring protocols as well as responsibilities for these tasks. Conservation zones and recommendations for management and monitoring from this report should be integrated into COLO's planning documents. Once the management agreement and management planning steps have been completed, Beaverdam Creek Natural Area should be placed on the Virginia Registry of Natural Areas.

Natural Heritage Resource Monitoring Recommendations

Table 14 contains information regarding natural heritage resource monitoring at Beaverdam Creek Natural Area. Monitoring of Florida adder's-mouth should consist of an annual visit to the site in August when the species should be at the peak of flowering. The site of the known plant and all suitable habitat in the vicinity should be searched for plants. Notations of abundance and general condition of the rare plants and the habitat should be made. Each plant or group of plants should be mapped as accurately as possible (**not** marked, which might attract collectors). Photo plots of each plant or group of plants should be taken and permanent photo points of the plants' habitat should be established and photographed. Threats from potential pest species such as eulalia, deer, and beaver should be qualitatively assessed during this visit.

Table 14. Natural heritage resource monitoring Table for Beaverdam Creek.

Natural Heritage Resource	Monitoring Level	Method(s)	Frequency	When
Florida Adder's- Mouth	I	search; note abundance, condition; map; check problem species; photo point; photo plot	once annually	August
Northern Spring Sideswimmer	I	search; collect specimens for ID; note condition of habitat; map collection points; photo point	once biannually	October
Spanish Moss	I	search; note abundance, condition; map; check pest species; photo point	once annually	June
Great Blue Heron, Great Egret	I	VDGIF survey; note # pairs; map colony location	once every three years	March

Amphipod species are difficult to differentiate in the field. Because more than one species could inhabit the same streamlet, specimens of amphipods that might be northern spring sideswimmers should be collected from each of several permanent points along the two streamlets (6-10 collection points total) once every two years. Specimens should be properly preserved, curated, and transferred to an expert for identification. Gravid individuals should be noted as they provide some evidence of reproduction at the site. The location at which each specimen was recorded should be recorded as should collection points at which no specimens

were found. When specimens are identified, points of collection of the northern spring sideswimmer can be mapped. General condition of the habitat should be noted at each collection point and in the vicinity in general. Two or more permanent photo points should be established and photographed annually. Collections and photographs should be made in October.

Intensive searches for Spanish moss in the area of the known plants should be conducted every June when plants flower. Abundance and condition of the plants should be noted. Plant locations should be mapped as accurately as possible. Two or more permanent photo points should be established. Threats from potential pest species (e.g., beavers) or human activities (e.g., collection) should be noted.

The heron and egret nesting colony is monitored every three years by VDGIF (Appendix B). Number of nesting pairs, location, and extent of the colony are recorded on aerial surveys in early spring.

Management Recommendations

All human activity except for research and monitoring should be restricted from habitat conservation zone C and disturbance conservation zone A from February 1 through August 31. Low level activities such as hiking, biking, horseback riding, and trail maintenance are acceptable in disturbance conservation zone A from September 1 through January 31, but should not be encouraged within habitat zone C. Habitat conservation zone C and disturbance conservation zone A may change as the nesting colony shifts in position. Education of park visitors regarding these zones is needed. Within habitat conservation zone D and disturbance conservation zone B, visitation should be limited to non-threatening conveyances such as walking. Visitors should be encouraged not to disturb foraging herons and not to collect Spanish moss.

For projects planned in the watershed conservation zone, steps should always be taken to avoid or minimize possible detrimental effects to natural heritage resources. The closer the project to the core area and the larger the scale of land disturbance, the more carefully the project should be reviewed before implementation and the more closely it should be monitored during and after implementation. Examples of activities which might impact the site include enlargement of the reservoir causing a water level rise which may alter rare plant habitats or major road construction that may destroy potential heron and egret habitat or disturb the nesting colony.

Beaver activity may threaten the natural heritage resources of the site. Water level alteration from beaver activity could flood Florida adder's-mouth habitat, cause the death of Spanish moss host trees, or possibly kill egret and heron nest trees. Beaver activities may also cause degradation or destruction of habitat or may affect water chemistry by increasing erosion and sedimentation. If beaver related impacts are suspected, the beaver population and effects of beaver activity should be monitored. Monitoring may involve tracking active family groups,

marking individuals, documenting alterations in hydrology, and observing for changes in vegetation. If beaver are determined to be threatening natural heritage resources, the beaver population or the effects of the beaver activity should be managed. Possible management options include trapping, shooting, or sterilization for control of the beaver population and exclusions or drainpipes for control or mitigation of beaver activity. Installation of drainpipes in beaver dams may be the most effective and practical method of attenuating beaver impacts to natural heritage resources (wetland permits may be required). COLO should work with DCR, VDGIF, and other resource management entities for help with monitoring and managing beaver.

Deer browse also may threaten the natural heritage resources of the site. Herbivory may directly damage or eliminate Florida adder's-mouth or may degrade its habitat. If deer related impacts are suspected, the effects of the deer population should be monitored. Monitoring may involve deer population studies, vegetation or habitat studies, or exclosure studies. If deer are determined to be threatening natural heritage resources, efforts to manage the deer population or its adverse effects should be implemented. Exclosures around small sensitive areas may be the most practical and effective means of reducing deer impacts at this site. COLO should work with DCR, VDGIF, and other resource management entities for assistance in monitoring and managing deer.

Invasive plant species may pose another threat to the natural heritage resources of the site. An invasive non-indigenous grass, eulalia, is already abundant in the natural area. If eulalia or other aggressive plant species are threatening the natural heritage resources of the site, consultation with DCR regarding monitoring and management of the threat is recommended.

Southern pine beetles (*Dendroctonus frontalis*) may attack the loblolly pines of the site, but infested trees should be left standing unless they pose a specific, documented safety hazard. The pines will continue to provide important habitat for both rare and common species for years after their demise.

Bracken's Pond Natural Area

Size: 194 ac (78 ha)

Biodiversity Rank: B4

Location: York County
Clay Bank and Yorktown 7.5 minute Quadrangles

General Description:

Bracken's Pond Natural Area includes a small, shallow pond, Bracken's Pond, a larger pond upstream, Roosevelt Pond, and the surrounding watershed. The small pond, which supports a rare plant population, is on park property, but nearly the entire watershed is part of the Yorktown Naval Weapons Station (YNWS).

Bracken's Pond is fed mostly by the outlet of Roosevelt Pond and, to a lesser degree, by runoff from the immediate vicinity of Bracken's Pond. Most of the natural area which is not open water is forested, and a substantial part of the upper watershed is developed.

The geology of the natural area generally consists of marine and estuarine silt and sand (the Windsor Formation) underlain by marine silt, sand, and shells (the Yorktown Formation). The sandy and calcareous sediments of the Yorktown Formation are exposed where streams have cut steep-walled ravines. Soils within the core conservation area are dominated by moderately well-drained to well-drained fine sandy loams. When found on steep slopes, such as the walls of ravines, these soils are highly erodible.

Current land uses within the core conservation area include recreational activities such as hiking, fishing, and possibly hunting (on YNWS property only). A significant portion of the peripheral conservation area contains storage buildings, roads, parking lots, and other facilities of the Yorktown Naval Weapons Station. The core area is traversed by the Colonial Parkway near Bracken's Pond and by a minor access road near Roosevelt Pond. The area has been a military base and park for many decades. Land use before that time is uncertain, but was likely agriculture and forestry.

The watershed containing Bracken's Pond Natural Area has a high priority rating for urban nonpoint source pollution potential.

Natural Heritage Resources

A healthy population of **fibrous bladderwort** (*Utricularia fibrosa*) (Table 15; photo-Appendix A) was first discovered in Bracken's Pond in 1971 and was documented again in 1990 during the natural heritage inventory and in 1993 by DCR and COLO staff on a follow-up site visit. The plants are especially plentiful in the east side of the pond.

Table 15. Natural Heritage Resources of Bracken's Pond Natural Area.

Common Name	Scientific Name	Global Rarity Rank	State Rarity Rank	US Legal Status	VA Legal Status	NHR O Rank*
Fibrous Bladderwort	<i>Utricularia fibrosa</i>	G4G5	S1	none	none	B

* natural heritage resource occurrence rank

Fibrous bladderwort is a small aquatic herb, often floating in tangled mats. Individual plants rarely exceed twelve inches in length and consist of fine, frequently-branching, under-water stems with a single stalk reaching above the water's surface upon which flowers are borne. Flowering stems bear limp, fine leaves and little bladders which both help to float the plant during flowering and trap tiny animals, an adaptation to gain nourishment in the nutrient poor waters this species inhabits. Fibrous bladderwort is typically found in low-nutrient, shallow pools and ponds. Fibrous bladderwort is extremely rare in the Commonwealth, currently documented from only two locations in the state. The species is common to uncommon in the rest of its range which includes Mississippi to Florida north to southeast Massachusetts.

Threat Assessment

Table 16 contains a threat assessment for Bracken's Pond. The principal threat to the fibrous bladderwort is alteration of water chemistry. Sedimentation, nutrient loading, or toxic chemicals could eliminate the population. Sediments from clearing¹ or construction may cover the plants directly as well as increase the turbidity in the pond decreasing the amount of light reaching the plants photosynthetic tissues. An increased influx of nitrogen, phosphorous, or both could also lead to decreased light penetration, as well as decreased dissolved oxygen levels and increased competition with species better adapted to high-nutrient regimes. Toxic chemicals, such as petroleum, pesticides, or polychlorinated biphenyls, could kill plants directly or destroy other species thus upsetting the pond ecosystem.

Conservation Zones

Bracken's Pond has three conservation zones (Table 17 and Figure 11). The habitat conservation zone contains Bracken's Pond itself, the habitat for the fibrous bladderwort. The surface-water conservation zone is conveniently delineated by several existing roads and includes about one half of the Bracken's Pond watershed proximal to the rare species population. This area encompasses Roosevelt Pond and, except for a few warehouses, wildlife clearings, and recreational fields, the area inside this surface-water zone is forested. The remainder of the Bracken's Pond watershed is encompassed by the watershed conservation zone.

1. For purposes of this document, "clearing" refers to any removal of canopy, understory, or herbaceous vegetation. For example, clearing includes removal of all vegetation to facilitate construction of new buildings, roads, or other structures; removal of all or certain trees for commercial purposes; or removal of selected stands of trees for pest control.

Table 16. Threat assessment for Bracken's Pond.

Stress: Effect	Presence: Degree	Source
Fibrous Bladderwort		
altered surface-water chemistry: change in nutrient cycle, sedimentation of plants, increased turbidity in pond, toxic contamination resulting in direct plant damage or habitat damage, displacement by high-nutrient adapted species	current:medium	clearing, construction, fertilizing, spills in watershed
altered surface-water flow: damage or destruction to habitat, decreased population vigor	potential:low	beaver activity; expansion of Roosevelt Pond; water withdrawal; repair of Colonial Parkway
direct habitat damage/destruction: reduced population vigor, complete elimination of population	potential:low	draining or raising of pond water level

Ownership

Of the 194 ac (78 ha) of Bracken's Pond Natural Area within the core conservation area, only 8 ac (3 ha or 4%) are owned by COLO. The remaining 186 ac (75 ha or 96%) are owned by the U.S. Department of Defense as the Yorktown Naval Weapons Station.

Protection Recommendations

Bracken's Pond Natural Area receives a limited degree of protection by virtue of its federal ownership. The aquatic habitats may receive some protection under the Federal Clean Water Act and other water chemistry/wetlands regulations. Projects proposed, funded, or permitted by federal agencies (such as COLO and YNWS) requires environmental review under the National Environmental Policy Act.

COLO owns the habitat of the rare plants, but the Yorktown Naval Weapons Station controls the watershed upon which they depend. A cooperative management agreement among COLO, DCR, and YNWS is recommended to protect fibrous bladderwort and insure compatible land uses in the watershed. Such an agreement should outline land use, project review coordination, monitoring protocols, and responsibilities for these tasks. Conservation zone, management, and monitoring recommendations from this report should be integrated into COLO's Resource Management Plan. Bracken's Pond should be nominated for placement on the Virginia Registry of Natural Areas.

Natural Heritage Resource Monitoring Recommendations

Monitoring of fibrous bladderwort should consist of an annual visit to the pond in mid-summer when plants are likely in full bloom (Table 18). The pond should be searched from the banks for plants. General abundance should be estimated along with condition of the plants and the pond. Beaver activity should be checked and assessed. Two or more permanent photo points

Table 17. Conservation Zones for Bracken's Pond.

Zone	Extent	Compatible, Incompatible Uses	Stress(es)
Fibrous Bladderwort			
habitat	Bracken's Pond	management and monitoring of rare plants; no direct or indirect alteration	direct habitat damage or destruction; altered surface-water chemistry; altered surface-water flow
surface-water	proximal half of Bracken's Pond watershed	no clearing, construction, water withdrawal, treated water discharge, fertilizing, pesticides application, or new storage tanks	altered surface-water chemistry and flow
watershed	entire watershed of Bracken's Pond	carefully consider activities which may affect surface-water chemistry or flow (<i>e.g.</i> clearing, chemical use or storage)	altered surface-water chemistry and flow

should be established and photographed annually. Photographs should focus on the pond surface and its banks so that changes in the rare plant habitat and its immediate vicinity can be documented. The condition of the pond's water chemistry should be assessed from visual indicators (*e.g.*, algal blooms) or, if available, via biological and chemical analysis.

Table 18. Monitoring for Bracken's Pond Natural Area.

Natural Heritage Resource	Monitoring Level	Method(s)	Frequency	When
Fibrous Bladderwort	I	search; note abundance, condition; check/assess beaver activity; photo point	once annually	July

Management Recommendations

Since most of the water flowing into Bracken's Pond comes from Roosevelt Pond, the surface-water conservation zone should remain as undisturbed as possible to protect the water chemistry and flow of Bracken's Pond. Activities such as clearing or construction of additional facilities should not be undertaken within the surface-water conservation zone. Within the watershed conservation zone, land use activities which may affect the surface-water chemistry or flow of Bracken's Pond should be carefully reviewed and considered before implementation. Steps should be taken to avoid or minimize possible detrimental effects to the fibrous bladderwort. The closer the project to the core conservation area and the larger the scale of the land disturbance, the more carefully the project should be reviewed before implementation and the more closely it should be monitored during and after implementation.

Beaver activity may potentially threaten the natural heritage resource of the site. Water level alteration from the beaver flowage could deepen the pond, reducing the amount of shallow

water habitat available to the fibrous bladderwort. Beaver activities on the vegetation surrounding the pond may also cause degradation of the aquatic habitat by increasing erosion and sedimentation. If beaver related impacts are suspected, the beaver population and effects of beaver activity should be monitored. Monitoring may involve tracking active family groups, marking individuals, documenting alterations in hydrology, and observing for changes in vegetation. If beaver are determined to be threatening the fibrous bladderwort, the beaver population or the effects of the beaver activity should be managed. Possible management options include controlling the beaver population or using exclusions or drainpipes for control of beaver activity. Installation of drainpipes in the beaver dam may be the most effective and practical method of attenuating beaver impacts to the natural heritage resource (wetland permits may be required). COLO should work with DCR, VDGIF, and other resource management entities for help with monitoring and managing beaver.

Although none appear to be established at the site at this time, invasive submergent or emergent plant species could threaten viability of the fibrous bladderwort if aggressive species become established at the pond. Should COLO staff suspect invasive plant species are threatening the natural area, they should contact DCR regarding monitoring and management of the pests.

If water chemistry of the pond is degraded by new land use patterns in the watershed, remedial actions will be necessary to restore the water chemistry.

Cheatham Ravines Natural Area

Size: 493 ac (200 ha)

Biodiversity Rank: B4

Location: York County
Williamsburg and Clay Bank Quadrangles

General Description:

Cheatham Ravines Natural Area is the result of a merger of three similar, adjacent sites delineated in the natural heritage inventory report (Ludwig *et al.* 1993): Cheatham Pond Ravines, Cub Creek, and Jones Mill Pond. The site includes some of the forested ravines along Cub Creek, Cheatham Pond, and Jones Millpond and a substantial amount of the forest surrounding these ravines. The area supports two rare plant species and a rare natural community. Additionally, the natural area supports several uncommon or disjunct plants.

The entire natural area is forested, except for some roads, utility corridors, game management openings, and ponds. The forest communities are second-growth and their composition varies with slope, aspect, and moisture. Loblolly pine (*Pinus taeda*), tuliptree (*Liriodendron tulipifera*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and various oaks and hickories (*Quercus* spp. and *Carya* spp.) are common tree species. Understory composition also varies; wax myrtle (*Myrica cerifera*), mountain laurel (*Kalmia latifolia*), American holly (*Ilex opaca*), and flowering dogwood (*Cornus florida*) are common.

Geology of the natural area consists of variously interbedded sand, silt, clay, and peat. The geologic strata include the Yorktown Formation, marine silts and sands with a high content of ancient shells often leading to very calcareous soil conditions. Soils in the ravines consist of highly erodible, calcareous sandy loams. Soils on the surrounding plateaus generally consist of fine sandy loams. In addition to surface-water run-off, small streams in the ravines are often fed by ground-water seeps and springs.

The predominant use of land in the natural area is passive recreation and low-impact military maneuvers. Largely forested military bases surround the natural area to the north, east and south; a local park lies to the west. Hazardous material problems have been reported from the adjacent U.S. Naval Supply Center. Historical land use included agriculture, forestry, and manufacturing.

The watershed containing this natural area has a high priority rating for urban nonpoint source pollution potential.

Natural Heritage Resources

Table 19 contains a summary of natural heritage resources of Cheatham Ravines. **Loesel's twayblade** (*Liparis loeselii*; photo-Appendix A) has been documented from Cheatham Ravines at three sites: along Cub Creek, at Cheatham Pond, and at Jones Millpond. The species was originally discovered in the area in the 1970's by a College of William and Mary student conducting a botany project. Surveys associated with the natural heritage inventory documented the three distinct sites in 1989. Searches for the species in all the ravines of the natural area north of the Colonial Parkway in 1995 located only the Cheatham Pond population. Counts of emergent plants can be misleading, as individuals of this species can remain dormant in the soil as tubers for extended periods of time.

Loesel's twayblade is an herb of the orchid family which is very rare in Virginia. It is currently known from 11 sites in eight Virginia coastal plain and mountain counties. The species is more common in some other parts of its range which includes much of eastern North America.

Table 19. Natural Heritage Resources of Cheatham Ravines.

Common Name	Scientific Name	Global Rarity Rank	State Rarity Rank	US Legal Status	VA Legal Status	NHR O Rank*
Loesel's Twayblade	<i>Liparis loeselii</i>	G5	S2	none	none	A,D#,B
Mountain Camellia	<i>Stewartia ovata</i>	G4	S2	none	none	D
Chinkapin Oak Woodland	submesotrophic woodland	G?	S2?	none	none	CD

* natural heritage resource occurrence rank # occurrence not within COLO boundaries

Loesel's twayblade grows four to ten inches tall, sprouts two oval leaves from the base, and bears yellowish-green flowers in a central flowering stalk in the late spring and early summer. A plant of moist, shaded, neutral to alkaline habitats, Loesel's twayblade is found in the calcareous ravines of this natural area. The species is a mountain-coastal plain disjunct in Virginia; it occurs on the coastal plain and in the mountains, but not on the intervening piedmont.

Mountain camellia (*Stewartia ovata*; photo-Appendix A) has become uncommon throughout its range, the southeastern U.S., and is considered very rare in Virginia because it is known to occur at only seven sites in five counties. A deciduous shrub or small tree of the tea family, mountain camellias have simple, oval leaves and bear white flowers in mid-summer. A single individual of the species was documented from a ravine slope along Cub Creek in 1989, but searches in 1993 and 1995 failed to find the plant. Mountain camellia tends to grow on wooded bluffs and slopes with alkaline soils, such as the calcareous ravine slopes in the Cheatham Ravines Natural Area. Mountain camellia is also a mountain-coastal plain disjunct.

A small occurrence (approximately 1/4 acre or 1000 m²) of a rare natural community, a **Chinkapin oak woodland** (a type of submesotrophic woodland; photo-Appendix A), was

documented from the Cheatham Ravines in 1995. The community is found on a small point of land next to Queen's Creek. The Chinkapin oak woodland is based on calcium-rich soils influenced by the Yorktown Formation. Moderately low nutrient conditions cause trees to be somewhat stunted producing many small canopy openings. These openings permit light-demanding herbaceous species to grow. Important component species include Chinkapin oak (*Quercus muehlenbergii*), eastern redbud (*Cercis canadensis*), northern gammagrass (*Tripsacum dactyloides*), Muehlenberg's sedge (*Carex muehlenbergii*), and tall nutrush (*Scleria triglomerata*). Little is known about the distribution and abundance of this community type, but it is potentially quite rare and warrants further study.

Threat Assessment

The natural heritage resources of Cheatham Ravines are faced with several current and potential threats, but none appear to be of high severity at this time (Table 20). Habitat alteration from clearing¹ of the forest is a potential (but not expected) stress facing all three natural heritage resources of the site. Clearing the understory or removing standing and fallen deadwood could be as detrimental as clearing the mature trees themselves. In addition to habitat destruction and direct destruction of the natural heritage resources, clearing may also encourage the establishment and spread of invasive pest species². Displacement of rare plants or change in habitat or community composition by invasive pest species is also a concern for all three of the natural heritage resources. Increased herbivory from white-tail deer (*Odocoileus virginianus*) may affect all three, but threatens Loesel's twayblade in particular.

Other threats to Loesel's twayblade include trampling from hunters, hikers, or other users of the site. Because the plant is growing in swampy areas, alteration of water chemistry or water flow is also a potential stress. The greatest potential source of water chemistry problems are from inappropriate forest management practices³ and wildlife management practices within the watershed and toxic or eutrophying chemicals from the Naval base.

Conservation Zones

Cheatham Ravines has three conservation zones (Table 21 and Figure 12) which address all three of the natural heritage resources present. The habitat conservation zone contains the habitat where the rare plants have been found, additional similar habitat where these species could occur, and the extent of the rare natural community. A 100 ft (30 m) wide forested buffer conservation zone surrounds the habitat zones. The purpose of the forested buffer conservation zone is to protect the habitat zone from the influences of outside perturbations. For example, the buffer

1. For purposes of this document, "clearing" refers to any removal of canopy, understory, shrub layer, or herbaceous layer vegetation. For example, clearing includes removal of all vegetation to facilitate construction of new roads, buildings, and other structures; removal of all or certain trees for commercial purposes; or removal of selected stands of trees for pest control.

2. For purposes of this document, "pest species" is used to refer to any species which may produce undesirable effects on natural heritage resources. For example, pest species may include invasive, non-native (or "exotic") plants, such as Japanese honeysuckle or tree-of-heaven, or may include native but potentially harmful animals, such as southern pine beetles or white-tailed deer.

3. Forest management activities on COLO property are limited to pest species and hazard control operations.

zone provides a filter strip to protect the habitat zone from sedimentation and helps isolate the habitat zone from the edge effect and its associated invasive species. The third conservation zone is a surface-water conservation zone which includes most of the surface watersheds of the ravines. The purpose of this zone is to protect the water chemistry and flow while facilitating compatible land use.

Ownership

Most of the natural area (almost 400 ac or 162 ha) is owned by COLO. The U.S. Naval Supply Center, Cheatham Annex has a memorandum of agreement with COLO to allow the Navy to use the area for passive recreation and low-impact military maneuvers. The remainder (about 100 ac or 40 ha) is owned by the U.S. Naval Supply Center, Cheatham Annex.

Table 20. Threat Assessment for Cheatham Ravines.

Stress: Effect	Presence: Degree	Source
Loesel's Twayblade		
habitat alteration: loss of habitat; invasion by shade intolerant species	potential:low	clearing; pine beetle control; maintenance, construction of roads, trails
displacement: direct displacement via competition or indirect displacement via habitat alteration	current:medium	pest plant invasion (eulalia already in vicinity)
herbivory: reduced vigor; loss of individuals, populations; failure to reproduce	current:medium	deer browse
collection, trampling: significant reduction of population	potential:low	hikers, collectors, cyclists (?)
altered surface-water chemistry: change in nutrient cycles; sedimentation of plants or habitat; toxic contamination resulting in death or reduced vigor of rare plants	potential:low	spills, leaks, wastewater discharge from Navy base; clearing, development in vicinity
altered surface-water flow: decreased population vigor	potential:low	beaver activity; lake enlargement
Mountain Camellia		
habitat alteration: loss of individual; loss of habitat	potential:low	clearing; pine beetle control; maintenance, construction of roads, trails
herbivory: reduced vigor; loss of individual, population; failure to reproduce	current:medium	deer browse
displacement: direct displacement via competition or indirect displacement via habitat alteration	potential:medium	pest plant invasion (e.g., tree-of-heaven)
Chinkapin Oak Woodland		
habitat alteration: loss/change of community	potential:low	clearing; pine beetle control; maintenance, construction of roads, trails
displacement: direct displacement via competition or indirect displacement via habitat alteration	potential:medium	pest plant invasion (e.g., tree-of-heaven, herbaceous weeds)

Protection Recommendations

Cheatham Ravines is already moderately well-protected by virtue of its almost complete ownership by COLO. The wetland habitats within the natural area also receive some protection from the Federal Clean Water Act which regulates alterations of many wetlands. Although federal agencies are not required to comply with state and local regulations, it is the stated intent of COLO to comply with local and state wetland protection measures and the Chesapeake Bay Protection Ordinance of York County. Projects proposed, funded, or permitted by a federal agency (such as COLO) may require environmental review under the National Environmental Policy Act.

COLO should be sure to apprise the resource management staff at U.S. Naval Supply Center, Cheatham Annex, (who uses the COLO property under an MOA) of the conservation recommendations in this document. Both the COLO-owned and Navy-owned areas should be placed on the Virginia Registry of Natural Areas.

Natural Heritage Resource Monitoring Recommendations

Table 22 contains monitoring recommendations. Monitoring of both Loesel's twayblade and mountain camellia should consist of an annual visit to the known stations for these species. The visits should be in June for Loesel's twayblade and in July for mountain camellia, when the species are normally at the peak of flowering. The site of the known plants and all suitable habitat in the vicinity should be searched. Notations of abundance and general condition of the rare plants and the habitat should be made. Each plant or group of plants should be mapped as accurately as possible (**not** marked, which might attract collectors). Photography points of each group of plants should be established and photographed. Threats from potential pest species such as eulalia (*Microstegium vimineum*) and white-tailed deer (*Odocoileus virginianus*) should be qualitatively assessed during these visits.

Monitoring of the chinkapin oak woodland should consist of the establishment of a permanent relevé plot with accompanying photography points. A relevé is a semi-quantitative method of characterizing a natural community. Biotic and abiotic features of the plot are recorded on standardized data forms. Advantages to relevé use include speed and ease of sampling and comprehensiveness. Disadvantages include the somewhat subjective nature of the process. Photographs should be taken along each of the four cardinal points (N, S, E, W) from the relevé plot center. All factors (location, lens size, film type, date, tripod height, etc.) should be kept as constant as possible from year to year. The relevé and photography points should be done once every three years. The recommended time of year to conduct the monitoring is August, when most of the vegetation will be in a mature state. Brief instructions and a standardized data form for relevés are presented in Appendix C. DCR staff ecologists should be consulted for more detailed information regarding relevé protocols.

Table 21. Conservation Zones for Cheatham Ravines.

Zone	Extent	Compatible, Incompatible Uses	Stress(es)
Loesel's Twayblade: habitat	ravine slopes and bottoms where species has been documented or has potential to be found	no clearing, timber harvest; no road, trail construction; occasional light foot traffic OK	habitat alteration; pest plant invasion; altered surface-water chemistry and flow; trampling, collecting
forested buffer	100 ft (30 m) wide forested strip up slope of habitat zone	no clearing, timber harvest; no road, trail construction; occasional light foot traffic OK (<i>e.g.</i> , hunting)	habitat alteration; pest plant invasion; altered surface-water chemistry and flow
surface-water	immediate watersheds of the ravines	no large-scale clearing; no additional development; limited small-scale forest management with BMP's OK; trails with BMP's OK; maintenance of existing roads with BMP's okay; no spills, diversions, etc.	altered surface-water flow and chemistry
Mountain Camellia: habitat	ravine slopes where species has been documented or has potential to be found	no clearing, timber harvest; no road, trail construction; occasional light foot traffic OK (<i>e.g.</i> , hunting)	habitat alteration; pest plant invasion; altered surface-water chemistry and flow; trampling, collecting
forested buffer	100 ft (30 m) wide forested strip up slope of habitat zone	no clearing, timber harvest; no road, trail construction; occasional light foot traffic OK (<i>e.g.</i> , hunting)	logging, clearing; pest plant invasion; altered surface-water chemistry and flow
surface-water	immediate watersheds of the ravines	no large-scale clearing; no additional development; limited small-scale forest management with BMP's OK; trails with BMP's OK; maintenance of existing roads with BMP's okay; no spills, discharges, ditching, water diversions, <i>etc.</i>	altered surface-water flow and chemistry
Chinkapin Oak Woodland: habitat	ridge where community is found	no clearing, timber harvest; no road, trail construction; occasional light foot traffic OK (<i>e.g.</i> , hunting)	habitat alteration, clearing; pest plant invasion; altered surface-water chemistry and flow; trampling, collecting
forested buffer	100 ft (30 m) wide forested strip around habitat zone	no clearing, timber harvest; no road, trail construction; occasional light foot traffic OK (<i>e.g.</i> , hunting)	habitat alteration, clearing; pest plant invasion; altered surface-water chemistry and flow
surface-water	immediate watersheds of the ravines	no large-scale clearing; no additional development; limited small-scale forest management with BMP's OK; trails with BMP's OK; maintenance of existing roads with BMP's okay; no spills, discharges, ditching, water diversions, <i>etc.</i>	altered surface-water flow and chemistry

Table 22. Natural heritage resource monitoring for Cheatham Ravines Natural Area.

Natural Heritage Resource	Monitoring Level	Method(s)	Frequency	When
Loesel's Twayblade	I	search; note abundance, condition; map; check pest species; photo point	once annually or biannually	June
Mountain Camellia	I	search; note abundance, condition; map; check pest species; photo point	once annually or biannually	July
Chinkapin Oak Woodland	I	relevé with photo points	once every three years	August

Management Recommendations

Land use within the habitat conservation zones and forested buffer conservation zones should be restricted to low intensity activities such as light foot traffic. Construction of trails, maintenance of existing roads, and limited forestry activities are generally compatible in the surface-water conservation zone if best management practices for minimization of non-point source pollution are strictly followed. Wastewater discharges, activities with a risk of hazardous material spills, ditching, and diversion of watercourses should be avoided in the surface-water conservation zone. Any existing hazardous materials sites within the watershed zone should be ameliorated rapidly.

Deer browse potentially may threaten the natural heritage resources of the natural area. Herbivory may directly damage or eliminate Loesel's twayblade and mountain camellia or may degrade the rare plant habitat and the rare natural community. If deer related impacts are suspected, the effects of the deer population should be monitored. Monitoring may involve deer population studies, vegetation or habitat studies, or exclosure studies. If deer are determined to be threatening natural heritage resources, efforts to manage the deer population or its adverse effects should be implemented. Exclosures around small sensitive areas may be the most practical and effective means of reducing deer impacts at this site. COLO should work with DCR, VDGIF, and Cheatham Annex resource management staff for help with monitoring and managing deer.

Invasive plant species may pose a threat to the natural heritage resources of the site. An invasive, non-indigenous grass, eulalia (*Microstegium vimineum*), is already abundant in the natural area. If eulalia or other aggressive plant species are threatening the natural heritage resources of the site, DCR should be consulted regarding monitoring and management of the threat.

Southern pine beetles (*Dendroctonus frontalis*) may attack the pines on the site, but infested trees should be left standing in the habitat and forested habitat buffer zones unless they pose a specific, documented safety hazard. The pines will continue to provide important habitat for both rare and common species for years to come after their demise. Small outbreaks of southern pine bark beetle in the surface-water zone may be managed through appropriate techniques with strict

adherence to best management practices. Gypsy moths (*Lymantria dispar*) may infest the site in the future. Generally, pesticide application for gypsy moth control is not recommended within the natural area. COLO should contact DCR should gypsy moths become an issue.

Jamestown Island Natural Area

Size: 809 ac (327 ha)

Biodiversity Rank: B4

Location: James City County
Hog Island and Surry 7.5 minute quadrangles

General Description:

Jamestown Island Natural Area includes the southern half of Jamestown Island along with a significant portion of open water around the island. Jamestown Island, the site of the first permanent English settlement in North America, lies in the James River and is about three miles (5 km) long and one and one half miles (1.4 km) wide. The island is home to a bird nesting colony and two other rare bird species.

Jamestown Island is approximately half forested (including forested wetlands) and half tidal herbaceous wetland. The forested areas, lying mostly on the northern part of the island, consist of mesic and hydric woodlands with loblolly pine (*Pinus taeda*) usually as the dominant species. Jamestown Island is located at the upper limits of brackish intrusion in the James River, therefore, the herbaceous wetlands show an interesting mix of brackish and freshwater species. Generally, the more salt tolerant species, such as big cordgrass (*Spartina cynosuroides*), dominate at the mouths of the creeks and guts while the species better adapted to freshwater, such as arrow arum (*Peltandra virginica*), predominate at the heads.

Surficial deposits on Jamestown Island consist of the Lynnhaven and Poquoson Members of the Tabb Formation and Holocene valley fills that overlie the Eastover Formation (Johnson and Hobbs 1994). The Eastover is composed of consolidated quartzose silty fine sand with scattered shells and is covered by younger sediments. The higher points of the Island are underlain by the Lynnhaven Member of the Tabb Formation. These deposits are composed of a basal gravelly sand, a middle sand and upper very clayey silty fine sand. The emergent land south of Passmore Creek is underlain by similar deposits but a younger sequence of Poquoson Member. A modern dune-beach complex borders the southwestern margin of the Island. Thick sequences of fluvial gravel and sand and overlying estuarine and herbaceous wetland muds occur below the herbaceous wetlands.

A one-lane tour road traverses the northern part of the island (outside the natural area) and has several short trails and interpretive areas associated with it. The natural area receives little use or visitation except perhaps on the island's James River beachfront. There are no park-maintained trails within the natural area, but there are a few informal trails which receive light use. The western-most part of the island (outside of the natural area) does have a visitor's center, parking areas, major interpretive facilities, and the ruins of the original Jamestown settlement. This area is subject to heavy visitation and pedestrian use. The waters surrounding Jamestown Island, the

James River to the south and the Back River and The Thorofare to the north, are often subject to moderate to heavy recreational and commercial boating traffic. A major marina is located about one mile northwest of the site. Jamestown Island has been a national park since the 1930's. Land use before that time included forest management and farming. The watershed containing this natural area rates in the top ten percent of all watersheds statewide for urban nonpoint source pollution potential.

Natural Heritage Resources

Table 23 shows a summary of natural heritage resource information from Jamestown Island Natural Area. A pair of **bald eagles** (*Haliaeetus leucocephalus*; photo-Appendix A) have been active on Jamestown Island since at least 1986. VDGIF in cooperation with the College of William and Mary have monitored the nest site annually. The Jamestown Island eagles have defended their territory every year and have fledged one or two young at least half of the years they have occupied the site. Although the nest was not active in the 1993-1994 season, the territory was occupied.

Table 23. Natural Heritage Resources of Jamestown Island Natural Area.

Common Name	Scientific Name	Global Rarity Rank	State Rarity Rank	US Legal Status	VA Legal Status	NHR O Rank*
Bald Eagle	<i>Haliaeetus leucocephalus</i>	G4	S2S3	threat.	endan.	A
Least Bittern	<i>Ixobrychus exilis</i>	G5	S2	none	none	AB
Great Blue Heron	<i>Ardea herodias</i>	G5	S3	none	none	C

* natural heritage resource occurrence rank

Bald eagles are the largest species of raptor found regularly in Virginia. Immature birds are brown with varying amounts of white mottling for four or five years before achieving the distinctive white head and tail of the adult. In addition to extensive forested areas required for nesting and roosting, bald eagles also need substantial stretches of forested shoreline for foraging. Bald eagles normally mate for life and usually nest in the same area each year. Mated pairs may use two or more alternate nest sites in the same area from year to year. Although different pairs of eagles show different degrees of sensitivity to human activity, all bald eagles are vulnerable to human disturbance, especially if normal human activity patterns to which eagles have become habituated are suddenly changed or increased. Visual screening and distance buffers from human activity is essential to bald eagle reproductive and foraging success.

Bald eagles are uncommon throughout much of their range and are considered rare to very rare in Virginia. The species is listed as threatened by the Federal Endangered Species Act and endangered pursuant to Virginia Endangered Species Act. Although bald eagle populations have made a steady recovery since the ban on the use of certain persistent pesticides in the United States, the species continues to be threatened by habitat loss and human disturbance.

A significant population of **least bitterns** (*Ixobrychus exilis*; photo-Appendix A) occupies the herbaceous wetlands of the natural area. There were estimated to be over thirty individuals living in the herbaceous wetlands around Passmore Creek during a survey in July of 1991. Because there are only thirteen known breeding sites in just eight counties for the species in Virginia, least bitterns are considered very rare in the Commonwealth. The species is more common in some other parts of its breeding range which includes most of the eastern United States.

Least bitterns are small wading birds which are distinctively tan and white underneath and greenish black on the crown and back. Least bitterns nest and forage in fresh to brackish water marshes, especially those containing stands of cattails. The birds nest solitarily or semi-colonially, building their nest in tall herbaceous wetland vegetation or small shrubs in the herbaceous wetland. Least bitterns forage for small fish, frogs, tadpoles, slugs, leeches, and many other small animals in shallow water, mud, or herbaceous wetland vegetation. Least bitterns are shy and secretive; they will "freeze" in a reed-like pose if approached. Habitat loss or alteration is the primary threat to the species. Disturbance can also be a threat.

A **great blue heron** (*Ardea herodias*; photo-Appendix A) colony occupies Jamestown Island not far from the bald eagle nest site. Great egrets (*Casmerodius albus*) may also be present in the colony. One hundred fifty-five pairs of great blue herons were documented in the colony during a 1994 aerial survey by VDGIF and the College of William and Mary.

Colonial nesting birds pack large numbers of nests into a few, small areas. This makes entire populations vulnerable to a single disturbance. For nesting, great blue herons require tall trees in a substantial, remote woodland close to water. Peak nesting times are March through May, but colonies are frequently active from February through July. Nests are typically rickety stick platforms. A clutch size of three or four is common. The herons also require shallow water habitats for foraging with an ample supply of the fish, amphibians, and crustaceans that form the core of their diet. Since herons may eventually kill the trees in which they nest, colony boundaries tend to slowly migrate across the landscape. This makes availability of additional nesting habitat around a colony essential to its continued occupation.

Great blue herons are the largest wading bird found in Virginia. Great blue herons are tall, long-necked, long-legged birds with a blue-gray back and a spear-like beak. The species is a year-round resident in Virginia. Great blue herons are quite widespread in eastern Virginia and populations appear to be increasing. This has put the species' status as a natural heritage resource under some deliberation. Although individuals are frequently encountered in wetlands of eastern Virginia, the species' habitat is limited and threatened by development pressures. Great blue heron's colonial nesting habits puts many individuals at risk to single disturbances.

A plant called the southern twayblade (*Listera australis*; photo-Appendix A) also occurs on Jamestown Island. This species was formerly monitored as a natural heritage resource by DCR,

but through surveys over the last few years enough locations for this plant have been documented to warrant its removal from the rare species list and placement on the watchlist.

Threat Assessment

Jamestown Island Natural Area is fortunate to experience little anthropomorphic threats at this time (Table 24). The most serious threat to the site is disturbance of nesting and foraging bald eagles. This stress appears to be relatively minor and should not become a serious problem unless visitation patterns on the island change (*e.g.*, increased beach use or construction of more extensive roads and trails). Other potential threats to the bald eagles are loss of habitat, toxic contamination, and shooting.

The principal potential threat to the least bittern population is alteration or destruction of their herbaceous wetland habitat. This could take the form of total destruction through draining, impounding, or filling or may include more subtle changes in the herbaceous wetland vegetation from sedimentation, nutrient loading, or pest species¹ invasion. Although least bitterns are generally fairly tolerant of human activity, a substantial increase in visitation to the herbaceous wetlands around Passmore Creek could cause problems for the species at the site.

The most important potential stress to the great blue herons is also disturbance from human activity. A loss or alteration of the forested and shallow water habitats the species requires could also lead to a decline.

Conservation Zones

Although Jamestown Island Natural Area has only two conservation zones, these are actually a composite of the interlaced conservation zones of the three rare bird species it supports (Table 25 and Figure 13). Each species has two key requirements for effective conservation which are protection of habitat and protection from disturbance.

The habitat conservation zone includes most of the southern half of the island plus shallow water habitat and 330 ft (100 m) of open water along a forested shoreline. For bald eagles, this habitat conservation zone protects forested areas needed for nesting and roosting and forested shoreline and nearshore water needed for foraging. Least bitterns occupy the herbaceous wetland and associated shrub and shallow water habitats. Great blue herons use all

1. For purposes of this document, "pest species" is used to refer to any species which may produce undesirable effects on natural heritage resources. For example, pest species may include invasive, non-native (or "exotic") plants, such as Japanese honeysuckle or tree-of-heaven, or may include native but potentially harmful animals, such as southern pine beetles or white-tailed deer.

Table 24. Threat assessment for Jamestown Island Natural Area.

Stress: Effect	Presence: Degree	Source
Bald Eagle		
disturbance: interference with energy uptake; interference with ability to care for young; exposure of eggs, young; reproductive failure; abandonment of site	current:low	recreational boaters; hikers, picnickers, <i>etc.</i> ; clearing near active nest; researchers (biological, archaeological, geological)
destruction of forest, forested shoreline: loss of nesting, roosting, foraging habitat; abandonment of site	potential:low	development; clearing
toxics: death of individuals; damage to reproductive physiology; population decline; abandonment of site	potential:low	spills; inappropriate chemical use; channel dredging (chlordecone?)
Least Bittern		
alteration, destruction of herbaceous wetland: loss of habitat; abandonment of site; increases in disease, predation, parasitism	potential:low	ditching, filling, draining, impounding; siltation; nutrient loading; toxic contamination; pest species invasion (common reed); succession; hurricanes
disturbance: abandonment of site	potential:low	significant increase in human use of area
Great Blue Heron		
disturbance: failure of colony; abandonment of site; interference with foraging	potential:low	boaters, hikers, picnickers, planes, helicopters
destruction of nest trees, habitat: abandonment of site	potential:low	clearing for road, trail construction, maintenance; timber harvest; development

these habitat types. Forested areas are protected to provide nesting habitat, while the herbaceous wetland and shallow water habitats provide foraging areas.

The disturbance conservation zone should be thought of as including the habitat conservation zone plus an additional area of open water at least 980 ft (300 m) wide around forested shoreline, and additional forested buffer areas between the herbaceous wetland and the tour road. Bald eagle nesting, roosting, and foraging activities are sheltered from disturbance by extensive forested areas which screens them from human activity and by distance from human activity to their perching areas provided by the herbaceous wetland and the open water buffer area around the forested shoreline. Least bitterns are less sensitive to disturbance, but inclusion of the herbaceous wetland guts in the disturbance conservation zone keeps human activity from reaching levels which will cause a problem for this species. A lack of disturbance to heron colonies is critical for their reproductive success. The disturbance conservation zone provides the appropriate distances and screening vegetation to protect nesting herons from disturbance as well as helping to minimize disturbance of foraging herons.

Table 25. Conservation Zones for Jamestown Island Natural Area.

Zone	Extent	Compatible, Incompatible Uses	Stress(es)
Bald Eagle			
habitat	known nest sites; additional nesting habitat; roosting habitat; foraging habitat (including 100 yd (91 m) riverward of forested shoreline)	no additional development; restriction of visitation to existing roads, trails; no maintenance of existing roads, trails within 440 yd (400 m) of active nesting, roosting, or foraging areas from 11/15 to 7/15	disturbance; clearing, alteration of forested shoreline
disturbance	all of habitat zone plus 300 yd (275 m) riverward of forested shoreline and some additional forest buffer	no beaching of boats; discourage recreational boaters, anglers from entering	disturbance
Least Bittern			
habitat	all shallow water areas, herbaceous wetland, and herbaceous wetland-upland ecotone on island	no additional development, roads, culverts, ditching, impounding; restrict visitation to existing roads, trails; no fertilizer or pesticide use; strict sedimentation prevention when maintaining existing roads, trails; restrict boat access into zone	alteration, destruction of herbaceous wetland; disturbance
Great Blue Heron			
habitat	mature pine forest stands for nesting and shallow water areas on and around island for foraging	no additional development, road construction, clearing; restrict visitation to existing roads, trails; restrict boat access; no road, trail maintenance within 300 yd (275 m) of colony or foraging areas from Feb - Aug except research and monitoring	disturbance; destruction of nest trees, habitat
disturbance	300 yd (275 m) riverward of shallow water around shoreline and some additional forest buffer	no landing of boats, discourage recreational boaters, anglers, etc. from entering zone	disturbance

Ownership

Jamestown Island Natural Area is entirely in public ownership. Approximately 612 ac (248 ha or 76%) is owned by the National Park Service. The remaining 197 ac (80 ha or 24%) is open water of the James River which is controlled by the Commonwealth of Virginia and, to some extent, the US Coast Guard.

Protection Recommendations

Jamestown Island's public ownership and management as a national park already afford it a significant amount of protection. All three bird species of concern on the island, their nests, and nest trees are protected from direct destruction or disturbance by the Migratory Bird Treaty Act. The bald eagle receives additional protection from the Bald Eagle Protection Act and the Federal Endangered Species Act. Wetlands within the natural area also receive some protection from the Federal Clean Water Act which regulates alterations of many wetlands. State and local laws exist which may also help protect the site, since the Park Service often chooses to voluntarily comply with these standards. These state and local laws include the Virginia Endangered Species Act, state and local wetlands laws, Virginia Submerged Lands Law, Virginia Coastal Primary Sand Dune Act, and state and local Chesapeake Bay preservation laws. Projects proposed, funded, or permitted by a federal agency (such as COLO) may require environmental review under the National Environmental Policy Act.

During a preliminary assessment of sites along the James River, Jamestown Island was considered for inclusion in the National Estuarine Research Reserve System (NERRS). Although it has not been determined if the island's wetlands meet the criteria of the NERRS program, designation as a National Estuarine Research Reserve would provide an added layer of protection for the natural heritage resources.

To afford the site's natural heritage resources more explicit protection, management and monitoring recommendations in this report should be integrated into the park's resource management plan and the natural area should be placed on the Virginia Registry of Natural Areas. COLO should also approach VDGIF and USFWS regarding compliance with endangered species regulations.

Natural Heritage Resource Monitoring Recommendations

See Table 26 for information regarding natural heritage resource monitoring at Jamestown Island Natural Area. The bald eagle nest site is monitored annually by VDGIF in cooperation with the College of William and Mary via aerial survey (Appendix B). Surveyors check for evidence of nesting activity and note numbers of eggs or young they observe in nests. Nest locations are also mapped. The heron nesting colony is also monitored by VDGIF by aerial survey (Appendix B), though only once every three years. Numbers of nesting pairs and location and extent of the colony are recorded on the early spring surveys.

Because of their secretive behavior, least bitterns are difficult to monitor quantitatively. The herbaceous wetlands of Passmore Creek and its tributaries should be surveyed for least bitterns annually every July. Active searches from a small boat or canoe and passive searches from a blind or secluded location should be conducted. The observer should note numbers and locations of least bitterns seen and heard as well as any evidence of nesting activity observed.

Management Recommendations

Land use within the natural area should be limited to legitimate natural heritage resource monitoring and cultural and scientific research activities. Road or trail construction, timber harvest, and other potentially disturbing activities should be restricted from within the disturbance conservation zone. Landing of boats on the beach should not be permitted.

Table 26. Natural heritage resource monitoring for Jamestown Island Natural Area.

Natural Heritage Resource	Monitoring Level	Method(s)	Frequency	When
Bald Eagle	II	VDGIF survey: check site for evidence of territory occupation, nesting activities, eggs, young; note numbers eggs, young; map nest location	annually	late winter to early spring
Least Bittern	I	actively and passively search Passmore Creek's herbaceous wetlands; note numbers seen, numbers heard, any nesting behavior or nests found	annually	July
Great Blue Heron	II	VDGIF survey: note # pairs, map colony location, boundaries	once every three years	March

Recreational boating and related activities should be discouraged within the open water areas of the natural area. It may be possible to place signs or buoys around the area or execute some other method of notification or education asking boaters to voluntarily stay away from the sensitive areas. This is a difficult issue, and drawing more attention to the site may be counter-productive.

Consultation with the Virginia Department of Game and Inland Fisheries, the Virginia Marine Resources Commission, and the U.S. Coast Guard would be necessary.

Bald eagle nest sites and heron colonies are mobile, shifting across the landscape over time. For this reason the following guidelines are recommended for eagle nests and heron colonies on the island. Access to within 250 yd (75 m) of any bald eagle nest which has been active within the last three years should be restricted year round with the exception of existing roads. Travelers of roads within this zone should be encouraged not to stop while passing through it. Large scale or loud activities, such as road repair or maintenance, should be restricted from within 440 yd (400 m) of any eagle nest from November 15 through July 15. Human activities within 100 yd (91 m) landward and 300 yd (275 m) riverward of forested shoreline should be discouraged year round to minimize disturbance to foraging bald eagles. All human activities should be restricted from within 300 yd (275 m) of heron colonies from February through August. VDGIF and USFWS should be consulted regarding compliance with regulatory requirements for these species.

Should pest species fall under suspicion of degrading the habitat of the natural heritage resources, they should be monitored. If monitoring determines that pest species are threatening the viability of the natural heritage resources, the pest species should be controlled to the best extent possible using environmentally sensitive techniques. Pest species which could potentially degrade the site include common reed (*Phragmites australis*), which may invade the herbaceous wetlands, and

white-tailed deer (*Odocoileus virginianus*), which may over browse the herbaceous and understory strata. It appears unlikely, however, that these species will threaten the natural heritage resources currently known from the site.

Southern pine beetles (*Dendroctonus frontalis*) may attack the loblolly pines of the site, but infested trees should be left standing unless they pose a specific, documented safety hazard. The pines will continue to provide important habitat for both rare and common species for years after their demise.

Queen Creek Natural Area

Size: 598 ac (242 ha)

Biodiversity Rank: B5

Location: York County and City of Williamsburg
Williamsburg 7.5 minute quadrangle

General Description:

Queen Creek Natural Area includes the upper tidal portion of Queen Creek, the surrounding herbaceous wetlands, and some of the surrounding upland woodlands. This natural area harbors four exemplary natural communities.

Queen Creek is a tidal tributary to the York River. Herbaceous wetlands line the creek up to the dam of Waller Mill Reservoir (a public water supply and local park). The salinity of the water decreases upstream such that saltwater vegetation dominates the herbaceous wetland in the lower reaches while brackish and fresh water species dominate in the upper reaches. The herbaceous wetlands of the lower two-thirds of Queen Creek have been heavily disturbed by ditching, boat traffic, and surrounding residential development. Upstream of the I-64 crossing, the herbaceous wetlands are less disturbed. Significant acreages of mature second growth woodland are found around the upper reaches of Queen Creek. Less disturbed forest stands are dominated by American beech (*Fagus grandifolia*), northern red oak (*Quercus rubra*), and white oak (*Quercus alba*). Tuliptree (*Liriodendron tulipifera*) and loblolly pine (*Pinus taeda*) predominate in the more disturbed and younger stands. American holly (*Ilex opaca*) and flowering dogwood (*Cornus florida*) are the most common understory species.

Eastover and Yorktown Formations crop out in the valley walls along upper Queen Creek. The valley floors are underlain by fluvial-estuarine and paludal deposits. The Eastover and Yorktown are comprised of fossiliferous sand with both whole and broken shell. Calcium carbonate content varies between 10 and 80 percent and produces an alkaline to slightly acid ground water. The overlying Windsor Formation is composed of a quartzose sand that grades upward into a very clayey fine sand silt. Although the herbaceous wetland deposits have a thick gravelly sand and medium to fine sand local unit, the upper part is a quartz saturated, compressive, organic rich mud.

Both the herbaceous wetland and the forested uplands within the natural area currently receive light recreational use, such as boating, fishing, hunting, and hiking. The natural area is traversed by major roads in three places. Historical use of the herbaceous wetland was likely little different from the use patterns of today. Evidence exists to suggest that the upland forests have been subject to intensive forestry activities in the past. Residential development lies to the east and south of the natural area, a military reservation occupies the land to the north, and a public reservoir and public park occupy lands to the west.

The watershed containing Queen Creek Natural Area has a high priority rating for urban nonpoint source pollution potential. Waller Mill Reservoir just upstream of the site is classified as mesotrophic, possibly caused by nonpoint sources of pollution.

Natural Heritage Resources

See Table 27 for a summary of the natural heritage resources at Queen Creek. Queen Creek Natural Area contains examples of **tidal freshwater and brackish marshes** (mid-height herbaceous palustrine wetland and mid-height herbaceous estuarine wetland, photos-Appendix A). The tidal marsh of the upper tidal portion of Queen Creek is in good condition and has a moderately high species diversity, but its relatively small size and level of disturbance prevent it from attaining a high occurrence rank. From the Waller Mill Reservoir dam downstream to the Route 132 crossing, the salinity and the tidal amplitude are low. The tidal marsh is dominated by a diversity of freshwater species such as arrow arum (*Peltandra virginica*), pickerel weed (*Pontederia cordata*), cattails (*Typha* spp.), and bulrushes (*Schoenoplectus* spp.). Between the Route 132 crossing and the I-64 crossing, the community becomes somewhat more brackish with species such as big cordgrass (*Spartina cynosuroides*) appearing, but diversity remains high with many freshwater species persisting. Shrub species, such as wax myrtle (*Myrica cerifera*), groundsel tree (*Baccharis halimifolia*), and marsh elder (*Iva frutescens*), add to the diversity of the wetland by growing in small patches in the wetland and along the wetland-upland border. Downstream of the I-64 crossing, the tidal marsh becomes more saline, less diverse, and more disturbed.

Healthy coastal freshwater and brackish tidal marshes and tidal creeks provide many ecological benefits. They enhance water chemistry, help to contain storm and flood waters, buffer against shoreline erosion, produce large amounts of nutrients and energy, and provide habitat for a vast array of vertebrates and invertebrates. Tidal creeks protected by freshwater and brackish tidal marshes provide spawning and nursery areas for fish and other aquatic animals. High quality herbaceous wetlands and creeks are essential to the productivity and health of the Chesapeake Bay. Freshwater tidal marshes are particularly valuable, because they are a rare natural community type (brackish and saline tidal marshes are relatively common) and normally harbor a high degree of plant diversity.

Queen Creek Natural Area contains two examples of a **southern mixed hardwood forest** (submesotrophic forest). The forest north of Queen's Lake School is of relatively poor quality. This stand has been subject to intensive forestry and is dominated by American beech and tuliptree with a strong loblolly pine component. Remnants of a once great forest remain in the stand, however, especially in the steep-walled ravines which were spared from past timber harvest. With time, this stand could grow into a fine example of this community type. Another stand southeast of the public water supply filtration plant is in better condition. This stand has many mature oaks, hickories (*Carya* sp.), beech, and tuliptree.

Table 27. Natural Heritage Resources of Queen Creek Natural Area.

Common Name	Scientific Name	Global Rarity Rank	State Rarity Rank	US Legal Status	VA Legal Status	NHR O Rank*
Tidal Brackish Marsh**	Mid-Height Herbaceous Estuarine Wetland	G5	S5	none	none	C
Tidal Freshwater Marsh**	Mid-Height Herbaceous Palustrine Wetland	G?	S3	none	none	C
Southern Mixed Hardwood Forest** (two occurrences)	Submesotrophic Forest	G?	S3	none	none	C,D
* natural heritage resource occurrence rank **occurrence not within COLO boundaries						

Large, mature southern mixed hardwood forests are an extremely valuable natural resource. Undisturbed, large, mature forests show old growth characteristics such as many huge, often hollow, trees, complex stratification, diverse species composition and age structure, and substantial amounts of fallen and standing dead wood. Herb layers will become diversified in open, mature woods, sometimes harboring rare plant species. The great diversity of habitats found in a mature southern mixed hardwood forest leads to a diverse animal community. Many neotropical migratory songbirds, a group of species facing drastic declines, depend upon mature forest for nesting habitat and migration corridors. Structurally diverse forests provide foraging and resting areas protected from predators for these nesting and migrating birds. A plethora of mammals, insects, and other animals depend heavily upon the availability of mature forests.

Threat Assessment

Because of its location in a rapidly urbanizing area, Queen Creek Natural Area faces a wide array of potential stresses (Table 28). The major stress currently facing the freshwater and brackish tidal marshes community is alteration of surface-water chemistry. These communities are already crossed by three major bridges, and intensive residential development lies just downstream of the natural area. Fortunately, most of the area around the upper freshwater tidal marsh has remained forested. Further road construction or development in the area seems inevitable. These activities could lead to increased erosion and sedimentation, nutrient loading, and toxic contamination of the surface water feeding into the wetlands and creek. Sewer or stormwater outfalls, poor agriculture or forestry practices, or chemical spills from one of the major roads or from the military base could also compromise the water chemistry.

Surface-water flow is also potentially threatened by some of the same activities which threaten the water chemistry. Development and road construction leading to increased impervious surface area in the watershed, placement of stormwater outfalls, or enlargement of Waller Mill Reservoir could increase or decrease the flow of water into or out of the wetlands to the degree that the communities' composition and structure are altered. Other potential threats to water flow include ditching, draining, or filling of the wetlands or creek or any large-scale earth-moving project in close proximity. Beavers (*Castor canadensis*) could also alter water level enough to change the

communities, particularly in the upper reaches of the creek or its tributaries. Water chemistry stress, water flow stress, or some other factor may lead to invasion by aggressive plant species such as common reed (*Phragmites australis*). Waterfront development and water access development could cause direct destruction of parts of the freshwater and brackish tidal marshes and the associated disturbances may give invasive species a foothold in the system. Wakes from heavy boat traffic could cause significant erosion of the banks.

Table 28. Threat Assessment for Queen Creek Natural Area.

Stress: Effect	Presence Degree	Source
Tidal Freshwater and Brackish Marsh		
surface-water chemistry alteration: eutrophication, sedimentation, toxic contamination, salinity changes leading to change of community composition and structure or elimination of community entirely	current:moderate	development; clearing; construction; spills, leaks, discharges, <i>etc.</i> ; poor agricultural or silvicultural practices
surface-water flow alteration: change in hydrologic regime leading to change or elimination of community	potential:moderate	ditching, draining, dredging, well-drilling, impounding; increased impervious surface area; clearing; construction; beaver activity; reservoir enlargement
displacement: displacement of community components via competition; alteration of community structure	potential:moderate	pest species (<i>e.g.</i> , beaver, common reed, purple loosestrife)
direct community alteration: elimination of parts of community; pest species invasion	potential:moderate	waterfront residential development; docks, marinas, boat ramps, boat landings; boat-wake caused erosion
Southern Mixed Hardwood Forest - table 28, continued		
direct community alteration: direct destruction of part or all of community; increased fragmentation; increased abrupt edge; increased isolation; decreased stand size	potential:moderate	clearing; development; road, utilities construction
displacement: alteration of community composition, structure via competition, parasitism, disease, <i>etc.</i>	potential:moderate	pest species (<i>e.g.</i> , gypsy moth, brown-headed cowbird, tree-of-heaven, kudzu vine)

The most serious stress to the southern mixed hardwood forest is clearing¹. Clearing the understory or clearing fallen and standing deadwood are equally as detrimental to the community as clearing the mature trees themselves. Development, transportation and utility corridors, and inappropriate forest management practices threaten to degrade the forest stands. Even small areas of clearing can damage the community significantly. The ecological value of a mature forest decreases greatly with decreases in its size. Many species require certain minimum areas of mature forest to maintain a population. Additionally, clearing increases the isolation of the stand from other stands, increases fragmentation, and increases the amount of abrupt forest edge. With increased edge and light penetration, pest species², such as the brown-headed cowbird (*Molothrus ater*), Japanese honeysuckle (*Lonicera japonica*), and kudzu (*Pueraria lobata*), are more likely to invade the forest. All of these factors can stress the forest, making it more susceptible to mortality caused by gypsy moth infestations or other diseases and parasites.

Conservation Zones

Queen Creek Natural Area has six conservation zones (Table 29 and Figures 14 and 15). Community conservation zone M encompasses the tidal freshwater and brackish marshes. The surface-water conservation zone consists of a 100 ft (30 m) wide forested upland buffer strip around the wetlands. These two zones are designed to protect the wetlands from threats in the immediate vicinity. The watershed conservation zone, which simply encompasses the watershed of Queen Creek, is designed to help protect the water chemistry and flow of the natural area from large scale or distant disturbances.

Community conservation zones F1 and F2 encompass the maturing southern mixed hardwood forest stands. A 100 ft (30 m) wide forested buffer conservation zone surrounds the community conservation zones except where the forest is contiguous with the herbaceous wetland. The

1. For purposes of this document, "clearing" refers to any removal of canopy, understory, shrub layer, or herbaceous layer vegetation. For example, clearing includes removal of all vegetation to facilitate construction of new roads, buildings, or other structures; removal of all or certain trees for commercial purposes; or removal of selected stands of trees for pest control.

2. For purposes of this document, "pest species" is used to refer to any species which may produce undesirable effects on natural heritage resources. For example, pest species may include invasive, non-native (or "exotic") plants, such as Japanese honeysuckle or tree-of-heaven, or may include native but potentially harmful animals, such as southern pine beetles or white-tailed deer.

purpose of the forested buffer conservation zone is to help protect the forest from the "edge effect." Where there is an abrupt change from forested to non-forested land, such as next to a powerline, road, or lawn, there is an edge effect in which the increased light and exposure to different vegetation cause changes in the forest. In addition to supporting a different flora and fauna from the interior forest, this edge area is many times more susceptible to increased disease, parasites, and pest species invasions. Where forest and herbaceous wetland meet, there is a gradual transition which acts as a natural buffer zone. This ecotone area contains components of each neighboring habitat as well as its own unique characteristics. The ecotone is a special habitat utilized by many transient and resident animal species.

Table 29. Conservation Zones for Queen Creek Natural Area.			
Zone	Extent	Compatible, Incompatible Uses	Stress(es)
Tidal Freshwater and Brackish Marsh			
Community M	freshwater/brackish tidal marshes upstream of I-64 bridge	no ditching, draining, filling, bulkheading, impounding, discharges; discourage intense boat traffic	direct community alteration, destruction; surface-water chemistry and flow alteration
surface-water	100 ft (30 m) upland of herbaceous wetland-upland border	same as above plus no clearing, development, utility corridor construction	surface-water chemistry and flow alteration; pest species invasion
watershed	surface watershed of Queen Creek	carefully consider before implementation of projects which may affect water chemistry or flow in natural area	direct community alteration; surface-water chemistry and flow alteration
Southern mixed Hardwood Forest			
community F1 and F2	extent of maturing forest	no clearing	clearing; pest species invasions
forested buffer	100 ft (30 m) wide forested zone around maturing forest	no clearing	clearing; pest species invasions

A peripheral conservation zone, the watershed conservation zone (Figure 15), includes all of the surface watershed of Queen Creek. This peripheral zone indicates an area in which land use changes may affect surface-water flow or chemistry and, thus, affect the herbaceous wetland communities.

Ownership

Much of the core conservation area north of Queen Creek is in public ownership either by the U.S. Department of Defense (Camp Peary Naval Reservation) or by the City of Williamsburg (Waller Mill Reservoir). Most of the natural area south of Queen Creek is in private ownership. A private foundation owns most of the forest community southeast of the Waller Mill filtration

plant. None land of the core conservation area is COLO property, but COLO owns a significant amount of land within the watershed conservation zone.

Protection Recommendations

The herbaceous wetland receives some protection from the federal, state, and local wetlands regulations as well as from state and local Chesapeake Bay preservation laws. The exemplary forest communities are privately owned and receive no legal protection. Projects proposed, funded, or permitted by federal agencies (such as COLO or Camp Peary) may require environmental review under the National Environmental Policy Act.

Negotiation of a management agreement between DCR and the major property holders within the natural area is recommended. The agreement(s) should outline compatible and incompatible land uses and responsibilities for management and monitoring of the site. The local governments should be approached regarding protection of the site through local comprehensive planning, zoning ordinances, and project review. The site should be placed on the Virginia Registry of Natural Areas.

Natural Heritage Resource Monitoring Recommendations

Table 30 contains natural heritage resource monitoring information for Queen Creek Natural Area. It is recommended that monitoring consist of the establishment of several permanent relevé plots with accompanying permanent photography points. Two representative areas should be chosen in each of the three communities. Permanent relevé plots and photography points should be established in the areas selected. A relevé is a semi-quantitative method of characterizing a natural community. Biotic and abiotic features of the plot are recorded on standardized data forms. Advantages to relevé use include speed and ease of sampling and comprehensiveness. Disadvantages include the inapplicability of inferential statistics and the somewhat subjective nature of the process. Photographs should be taken along each of the four cardinal points (N, S, E, W) from each relevé plot center. All factors (location, lens size, film type, date, tripod height, etc.) should be kept as constant as possible from year to year. Relevés and photography should be done once every three years. The recommended time of year to conduct the monitoring is August when most of the vegetation will be in a mature state. Brief instructions regarding relevé plots are presented in Appendix C. DCR staff biologists should be consulted for more detailed information regarding relevé protocols.

Management Recommendations

Ditching, draining, filling, bulkheading, pier construction, impounding, development, road construction, utility crossings, clearing and other disturbing activities should not take place within the community M, community F1, community F2, surface-water, and forested buffer conservation zones. Additionally, intense boat traffic on Queen Creek within community M conservation zone should be discouraged, but light use by small boats, such as canoes, is compatible. Clearing of any kind for any purpose should not take place within the community conservation zone F1 or F2 or the forested buffer conservation zone. Any projects which may

affect the water chemistry or flow of the natural area planned for within the watershed conservation zone should be carefully reviewed and considered before implementation. Steps

Table 30. Monitoring for Queen Creek and Cheatham Annex.

Natural Heritage Resource	Monitoring Level	Method(s)	Frequency	When
tidal freshwater and brackish marsh	I	relevés with photo points	every three years	August
southern mixed hardwood forest	I	relevés with photo points	every three years	August

should always be taken to avoid or minimize possible detrimental effects to the natural area. The closer the project to the core area of the natural area or the larger scale the land disturbance, the more carefully the project should be reviewed before implementation and the more closely it should be monitored during and after implementation.

White-tailed deer (*Odocoileus virginianus*) browse may potentially threaten the natural heritage resources of the site. Herbivory may damage or even completely eliminate the ground level and understory vegetation of the exemplary southern mixed hardwood forest stands. If deer related impacts are suspected, the effects of the deer should be monitored. Monitoring may involve deer population studies, vegetation or habitat studies, or exclosure studies. If deer are determined to be threatening natural heritage resources, efforts to manage the deer population or its adverse effects should be implemented. COLO and other managers of this site should work with VDGIF and other resource management entities in monitoring deer.

Gypsy moth (*Lymantria dispar*) infestation may threaten the southern mixed hardwood forest occurrences. Large gypsy moth infestations can completely defoliate a forest stand causing at least a temporary increase in the amount of light reaching the forest floor and may lead to limited tree mortality. Control of gypsy moths usually involves the broadcast spraying of insecticides. The two most commonly used insecticides, diflubenzuron and *Bacillus thuringiensis*, are known to have significant impacts to non-target species. Fungal and viral based pesticides which are specific to gypsy moths do exist, but are often limited in availability or prohibitively expensive. There are also some other methods of gypsy moth control (e.g., barrier bands, pheromone flakes) which vary in effectiveness. For these reasons, gypsy moth infestations often present natural area management dilemmas. If gypsy moth infestation becomes imminent at the site, DCR should be consulted for recommendations.

Invasive pest plant species pose another potential threat to the natural heritage resources of the site. Invasive wetland plants, particularly common reed (*Phragmites australis*), may impact the freshwater and brackish tidal marsh communities and other invasive plants, such as Japanese honeysuckle (*Lonicera japonica*) and kudzu (*Pueraria lobata*), may impact the forest communities. DCR should be consulted regarding monitoring and management if invasive plants are threatening the site.

Southern pine beetles (*Dendroctonus frontalis*) may attack the pines of the site, but infested trees should be left standing unless they pose a specific, documented safety hazard. The pines will continue to provide important habitat for both rare and common species for years after their demise.

Swann's Point Natural Area

Size: 572 ac (231 ha)

Biodiversity Rank: B5

Location: Surry County
Surry 7.5 minute Quadrangle

General Description:

Swann's Point is a promontory on the south shore of the James River near Jamestown Island. Swann's Point Natural Area includes the forests and wetlands (forested and non-forested) of Swann's Point, approximately one mile of forested shoreline on either side of Swann's Point, and a substantial area of nearshore open water in the James River and Grays Creek. The area supports a bird nesting colony and a rare bird species.

The forest within the natural area is dominated by loblolly pine (*Pinus taeda*) and has an open to dense understory. The herbaceous wetlands are brackish to freshwater dominated by big cordgrass (*Spartina cynosuroides*) with black needle rush (*Juncus roemerianus*), cattails (*Typha* spp.), and arrow arum (*Peltandra virginica*) components.

General geology of the natural area consists of unconsolidated fine to coarse grained sand, silt, and clay often with ancient shells. A soil survey of Surry County has not been published, therefore, soil information is not available.

Human activity within most of the natural area appears to be light. Hunting and fishing probably occur in parts of the natural area outside of the COLO boundaries. The open water area included in the natural area receives light to moderate recreational boat traffic and associated activities such as fishing and water-skiing. The surrounding landscape is rural with most of the land in row crops or managed forests. Several rural residences occur close to the natural area. Historical uses of the area were likely similar to current uses.

The watershed containing Swann's Point Natural Area falls in the top ten percent of all watersheds statewide for urban nonpoint source pollution potential.

The Virginia State Fossil, the Chesapeake scallop (*Chesapecten jeffersonius*), has been documented from Swann's Point. This fossil comes only from the Sunken Meadow Member of the Yorktown Formation where it is very abundant. It was the first fossil described from North America by Martin Lister in 1687.

Natural Heritage Resources

Table 31 contains a summary of natural heritage resource information for Swann's Point Natural Area. A pair of **bald eagles** (*Haliaeetus leucocephalus*; photo-Appendix A) have been active at Swann's Point since at least 1991. A recent survey by VDGIF and the College of William and Mary indicated the pair produced one offspring in the 1994 season.

Table 31. Natural Heritage Resources of Swann's Point Natural Area.						
Common Name	Scientific Name	Global Rarity Rank	State Rarity Rank	US Legal Status	VA Legal Status	NHR O Rank*
Bald Eagle	<i>Haliaeetus leucocephalus</i>	G4	S2S3	threat.	endan.	B
Great Blue Heron	<i>Ardea herodias</i>	G5	S3	none	none	U
* natural heritage resource occurrence rank						

Bald eagles are the largest species of raptor found regularly in Virginia. Immature birds are brown with varying amounts of white mottling for four or five years before achieving the distinctive white head and tail of the adult. In addition to extensive forested areas required for nesting and roosting, bald eagles also need substantial stretches of wooded shoreline for foraging. Bald eagles normally mate for life and usually nest in the same area each year. Mated pairs may use two or more alternate nest sites in the same area from year to year. Although different pairs of eagles show different degrees of sensitivity to human activity, all bald eagles are vulnerable to human disturbance, especially if normal human activity patterns to which eagles have become habituated are suddenly changed or increased. Visual screening and distance buffers from human activity is essential to bald eagle reproductive and foraging success.

Bald eagles are uncommon throughout much of their range and are considered rare to very rare in Virginia. The species is listed as threatened by the Federal Endangered Species Act and endangered by the Virginia Endangered Species Act. Though bald eagle populations have made a steady recovery since the ban on the use of certain persistent pesticides in the United States, the species continues to be threatened by habitat loss and human disturbance.

A **great blue heron** (*Ardea herodias*; photo-Appendix A) nesting colony occupies Swann's Point not far from the bald eagle nest site. Ninety pairs of great blue herons were documented in the colony during a 1994 aerial survey by VDGIF and the College of William and Mary. Great egrets (*Casmerodius albus*) may also utilize the colony site.

Colonial nesting birds pack large numbers of nests into a few, small areas. This makes entire populations vulnerable to a single disturbance. For nesting, great blue herons require tall trees in a substantial, remote woodland close to water. Peak nesting times are March through May, but colonies are frequently active from February through July. Nests are typically rickety stick platforms. A clutch size of three or four is common. The herons also require shallow water habitats for foraging with an ample supply of the fish, amphibians, and crustaceans that form the

core of their diet. Since herons eventually kill the trees in which they nest, colony boundaries tend to slowly migrate across the landscape. This makes the availability of additional nesting habitat around a colony essential to its continued occupation.

Great blue herons are the largest wading bird found in Virginia. Great blue herons are tall, long-necked, long-legged birds with a blue-gray back and a spear-like beak. The species is a year-round resident in Virginia. Great blue herons are quite widespread in eastern Virginia and populations appear to be increasing. This has put the species' status as a natural heritage resource under some deliberation. Although individuals are frequently encountered in the wetlands of eastern Virginia, the species' habitat is limited and threatened by development pressures plus the species nests colonially putting more individuals at risk to single disturbances.

During a visit to the site in the autumn of 1993, a natural heritage zoologist discovered a potentially rare orb-weaving spider, *Gasteracantha cancriformis*, at Swann's Point. The status of this species in Virginia is currently undetermined and it has been placed on the animal watchlist.

Threat Assessment

Because of its relatively rural setting, Swann's Point Natural Area is currently subject to little anthropomorphic stress, but increasing populations and changing land use patterns characteristic of the eastern Virginia loom as potential threats to the site (Table 32). The most important potential stress to both the bald eagles and great blue herons is disturbance. Increased visitation of the site, changes in land use (*e.g.*, large scale development), and increased recreational boat traffic may disturb the nesting, roosting, and foraging activities of the birds to the point that they abandon the site. Clearing¹ of the mature, isolated forest, modification of the forested shoreline, and alteration of the herbaceous wetland or near-shore shallow water habitat may also cause elimination of great blue herons and bald eagles from the site (though, these events are not expected within the park boundary).

Conservation Zones

The habitat conservation zone and the disturbance conservation zone of Swann's Point Natural Area serve to protect both the bald eagle pair and the great blue heron nesting colony (Figure 16 and Table 33). The habitat conservation zone is a composite of bald eagle and great blue heron habitat. Included are mature pine stands for nesting activities of both species,

1. For purposes of this document, "clearing" refers to any removal of canopy, understory, shrub layer, or herbaceous layer vegetation. For example, clearing includes removal of all vegetation to facilitate construction of new roads, buildings, or other structures; removal of all or certain trees for commercial purposes; or removal of selected stands of trees for pest control.

herbaceous wetland for heron foraging habitat, forested shoreline for eagle perching habitat, and near-shore shallow water for eagle and heron foraging habitat. The disturbance

Table 32. Threat Assessment for Swann's Point Natural Area.		
Stress: Effect	Presence: Degree	Source
Bald Eagle		
disturbance: interference with energy uptake; interference with ability to care for young; exposure of eggs, young; reproductive failure; abandonment of site	current:low	recreational boaters; hikers, picnickers, <i>etc.</i> ; certain forestry, agricultural activities near active nest
direct habitat alteration (forest, forested shoreline): loss of nesting, roosting, foraging habitat; abandonment of site	potential:low	development; clearing
toxics: death of individuals; damage to reproductive physiology; population decline; abandonment of site	potential:low	spills; unwise chemical use; channel dredging (chlordecone?)
Great Blue Heron		
disturbance: failure of colony, abandonment of site; interference with foraging	potential:low	boaters, hikers, picnickers, anglers, planes, helicopters
direct habitat alteration (forest, wetland): abandonment of site	potential:low	clearing

conservation zone **includes** the habitat conservation zone plus 300 yd (275 m) of open water riverward of forested shoreline and a 100 yd (91 m) wide forested swath landward of the habitat zone. The purpose of the habitat conservation zone is to provide a minimal amount of nesting, roosting, and foraging habitat for both species. The disturbance conservation zone helps shelter the birds from human activity.

Ownership

Around 125 ac (50 ha or 22%) of Swann's Point Natural Area is owned by COLO. Although in private ownership, land use in the forested shoreline area within the natural area west of promontory is controlled by COLO through a scenic easement. Forested shoreline within the natural area south of Swann's Point (along Gray's Creek) is in private ownership. The open water portions of the natural area are in public ownership (as waters of the Commonwealth).

Protection Recommendations

The eagle and heron nesting areas and some of their foraging areas already benefit from some protection by virtue of their ownership by COLO. The herbaceous wetland and other wetland habitats of Swann's Point Natural Area receive some protection from federal, state, and local wetlands protection regulations and from state and local Chesapeake Bay preservation regulations. Both bald eagles and great blue herons, their eggs, young, and nests are protected

from direct harm or disturbance by the Federal Migratory Bird Treaty Act. Bald eagles receive additional protection from the Federal Eagle Protection Act, the Federal Endangered Species Act, and the Virginia Endangered Species Act. Projects proposed, funded, or permitted by federal agencies (such as COLO) may require environmental review under the National Environmental Policy Act. Swann's Point may benefit from project review under this process.

COLO should approach VDGIF and USFWS regarding compliance with endangered species regulations. Recommendations from VDGIF, USFWS, and DCR should be integrated into COLO's resource management plan. Swann's Point Natural Area should be placed on the Virginia Registry of Natural Areas.

Natural Heritage Resource Monitoring Recommendations

See Table 34 for information regarding natural heritage resource monitoring and Swann's Point Natural Area. The bald eagle nest site is monitored annually by VDGIF in cooperation with the College of William and Mary via aerial survey (Appendix B). Surveyors check for evidence of nesting activity and note numbers of eggs or young they observe in nests. Nest locations are also mapped. The heron nesting colony is also monitored by VDGIF by aerial survey (Appendix B), though only once every three years. Numbers of nesting pairs and location and extent of the colony are recorded on the early spring surveys.

Management Recommendations

Land use within the natural area should be restricted to natural heritage resource monitoring and cultural and ecological research activities. In general, clearing, development, wetland alteration, road or utility construction, and increased levels of visitation should not occur within the habitat or disturbance conservation zones. Bald eagle nest sites and heron colonies are mobile, that is, they may shift across the landscape over time. For this reason the following guidelines are recommended for eagle nests and herons colonies on the site. Access to within 250 yd (230 m) of any bald eagle nest which has been active within the last three years should be restricted year round with the exception of existing roads. Travelers of roads within this zone should be encouraged not to stop while passing through it. Large scale or loud activities, such as road repair or maintenance, should be restricted within 440 yd (400 m) of any eagle nest from November 15 through July 15. Human activities within 100 yd (91 m) landward and 300 yd (275 m) riverward of forested shoreline should be discouraged to minimize disturbance to foraging bald eagles year round. All human activities should be restricted from within 300 yd (275 m) of heron colonies from February through August.

Boating through or inside of the open water zones of the natural area should be discouraged. Activities such as landing boats, anchoring, trolling, and water skiing can be especially disturbing to foraging eagles and herons. If a boater must pass through the open water zone of the natural area (as to access upper Gray's Creek), they should remain in the middle of the channel and pass straight through at a steady speed. It may be possible to place signs or buoys around the area or execute some other method of notification or education asking boaters

Table 33. Conservation Zones for Swann's Point Natural Area.

Zone	Extent	Compatible, Incompatible Uses	Stress(es)
Bald Eagle			
habitat	known nest sites; additional nesting habitat; roosting habitat; foraging habitat (including 100 yd or 91 m riverward of forested shoreline)	no clearing, development, road construction; seasonal and permanent access restriction of visitation; no roads, trails within 440 yd (400 m) of active nesting, roosting, foraging areas from 11/15 to 7/15	disturbance; direct habitat alteration
disturbance	all of habitat zone plus 300 yd (275 m) riverward and 100 yd (91 m) of landward of forested shoreline	no clearing, development, road or trail construction; permanent and seasonal land water -based access restrictions	disturbance
Great Blue Heron			
habitat	mature pine stands, herbaceous wetland, and near-shore shallow water areas	no development, clearing, wetland alteration; no road, trail construction; seasonal access restrictions to vicinity of colony; no access within 300 yd (275 m) of colony or foraging areas from Feb - Aug except research and monitoring	disturbance; direct habitat alteration
disturbance	habitat zone plus 100 yd (91 m) riverward of near-shore shallow water habitats	no landing of boats, anchoring, trolling, skiing, discourage recreational boaters, anglers from entering zone	disturbance

Table 34. Monitoring for Swann's Point Natural Area

Natural Heritage Resource	Monitoring Level	Method(s)	Frequency	When
Bald Eagle	II	VDGIF survey: check site for evidence of territory occupation, nesting activities, eggs, young; note numbers eggs, young; map nest location	annually	late winter to early spring
Great Blue Heron	II	VDGIF survey: note # pairs, map colony location, boundaries	once every three years	March

to voluntarily stay away from the sensitive areas. This is a difficult issue, and drawing more attention to the site may be counter-productive. Consultation with the Virginia Department of Game and Inland Fisheries, the Virginia Marine Resources Commission, and the U.S. Coast Guard would be necessary.

Southern pine beetles (*Dendroctonus frontalis*) may attack the loblolly pines of the site, but infested trees should be left standing unless they pose a specific, documented safety hazard. The pines will continue to provide important habitat for both rare and common species for years after their demise.

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APPENDIX D: SCIENTIFIC AND TECHNICAL NAMES

Following is an alphabetical listing of all species common names found in this report along with their scientific names and an alphabetical listing of the common names of the natural communities with their technical names. Scientific and technical names are also given parenthetically after the first usage in the text and in each site account.

SPECIES NAMES

common name	scientific name
America beech	<i>Fagus grandifolia</i>
American eel	<i>Anquilla rostrata</i>
American holly	<i>Ilex opaca</i>
arrow arum	<i>Peltandra virginica</i>
Atlantic croaker	<i>Micropogonias undulatus</i>
bald cypress	<i>Taxodium distichum</i>
bald eagle	<i>Haliaeetus leucocephalus</i>
bamboo	<i>Phyllostachys aurea</i>
beaver	<i>Castor canadensis</i>
big cordgrass	<i>Spartina cynosuroides</i>
black cherry	<i>Prunus serotina</i>
black gum	<i>Nyssa sylvatica</i>
black needle rush	<i>Juncus roemerianus</i>
black walnut	<i>Juglans niger</i>
blue crab	<i>Callinectes sapidus</i>
bluegill	<i>Lepomis macrochirus</i>
broad-leaved cattail	<i>Typha latifolia</i>
brown-headed cowbird	<i>Molothrus ater</i>
bulrushes	<i>Schoenoplectus species</i>
Canada goose	<i>Branta canadensis</i>
Canadian thistle	<i>Carduus arvensis</i>
cattails	<i>Typha species</i>
channel catfish	<i>Ictalurus punctatus</i>
Chesapeake scallop	<i>Chesapecten jeffersonius</i>
chestnut oak	<i>Quercus montana</i>
chinkapin oak	<i>Quercus muehlenbergii</i>
common paw paw	<i>Asimina trilobata</i>
common reed	<i>Phragmites australis</i>
crayfish	Order Decapoda
eastern cottontail rabbit	<i>Sylvilagus floridanus</i>
eastern gray squirrel	<i>Sciurus carolinensis</i>
eastern oyster	<i>Crassostrea virginica</i>
eastern redbud	<i>Cercis canadensis</i>

empress tree	<i>Paulownia tomentosa</i>
eulalia	<i>Microstegium vimineum</i>
false hop sedge	<i>Carex lupuliformis</i>
fibrous bladderwort	<i>Utricularia fibrosa</i>
Florida adder's-mouth	<i>Malaxis spicata</i>
flowering dogwood	<i>Cornus florida</i>
gray fox	<i>Urocyon cinereoargenteus</i>
great blue heron	<i>Ardea herodias</i>
great egret	<i>Casmerodius albus</i>
green ash	<i>Fraxinus pennsylvanica</i>
gypsy moth	<i>Lymantria dispar</i>
groundsel tree	<i>Baccharis halimifolia</i>
hard clam	<i>Mercenaria mercenaria</i>
hickory	<i>Carya species</i>
Japanese honeysuckle	<i>Lonicera japonica</i>
Johnson grass	<i>Sorghum halapense</i>
kudzu vine	<i>Pueraria lobata</i>
large-mouth bass	<i>Micropterus salmoides</i>
least bittern	<i>Ixobrychus exilis</i>
loblolly pine	<i>Pinus taeda</i>
Loesel's twayblade	<i>Liparis loeselii</i>
marsh elder	<i>Iva frutescens</i>
mockernut hickory	<i>Carya alba</i>
mountain camellia	<i>Stewartia ovata</i>
mountain laurel	<i>Kalmia latifolia</i>
muskrat	<i>Ondatra zibethica</i>
Muehlenberg's sedge	<i>Carex muehlenbergii</i>
northern gammagrass	<i>Tripsacum dactyloides</i>
northern red oak	<i>Quercus rubra</i>
northern spring sideswimmer	<i>Gammarus pseudolimnaeus</i>
oak	<i>Quercus species</i>
Parker's pipewort	<i>Eriocaulon parkeri</i>
pickerelweed	<i>Pontederia cordata</i>
raccoon	<i>Procyon lotor</i>
red fox	<i>Vulpes vulpes</i>
red maple	<i>Acer rubrum</i>
Shumard's oak	<i>Quercus shumardii</i>
small whorled pogonia	<i>Isotria medeoloides</i>
smartweeds	<i>Polygonum species</i>
Spanish moss	<i>Tillandsia usneoides</i>
spot	<i>Leiostomas xanthurus</i>
southern pine beetle	<i>Dendroctonus frontalis</i>

southern twayblade	<i>Listera australis</i>
striped bass	<i>Morone saxatilis</i>
sunfish	<i>Lepomis</i> sp.
sweetgum	<i>Liquidambar styraciflua</i>
sycamore	<i>Platanus occidentalis</i>
tall nutrush	<i>Scleria triglomerata</i>
tuliptree	<i>Liriodendron tulipifera</i>
tree-of-heaven	<i>Ailanthus altissima</i>
Virginia least trillium	<i>Trillium pusilum</i> var. <i>virginianum</i>
Virginia opossum	<i>Didelphis virginiana</i>
Virginia pine	<i>Pinus virginiana</i>
wax myrtle	<i>Myrica cerifera</i>
white ash	<i>Fraxinus americanus</i>
white oak	<i>Quercus alba</i>
white perch	<i>Morone americana</i>
white-tailed deer	<i>Odocoileus virginianus</i>
willow oak	<i>Quercus phellos</i>
yellow perch	<i>Perca flavescens</i>

NATURAL COMMUNITIES

common name	technical name
chinkapin oak woodland	submesotrophic woodland
southern mixed hardwood forest	submesotrophic forest
tidal brackish marsh	mid-height herbaceous estuarine wetland
tidal freshwater marsh	mid-height herbaceous palustrine wetland

APPENDIX E: ACRONYMS

Acronyms used within this document are defined below. Acronyms are also defined parenthetically at their first use within the text.

BCD	Biological Conservation Datasystem
BMP	Best Management Practices
DCR	Virginia Department of Conservation and Recreation
COLO	Colonial National Historical Park
NEPA	National Environmental Policy Act
NERRS	National Estuarine Research Reserve System
NHR	Natural Heritage Resource
NPS	National Park Service
ORV	Off-Road Vehicle
RMA	Resource Management Area
RPA	Resource Protection Area
RTE	Rare, Threatened, and Endangered
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VDACS	Virginia Department of Agriculture and Consumer Services
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
YNWS	Yorktown Naval Weapons Station